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## Energy saving concept development for the MORE-CONNECT pilot energy renovation of apartment blocks in Denmark

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### Abstract

The European Horizon2020 project MORE-CONNECT on prefabricated deep energy renovation of residential dwellings also covers pilot demonstration projects, which are to be carried out in six of the participating countries. For each country a unique, climate specific concept development analysis is carried out. The concept development follows the MORE-CONNECT methodology and thus aims towards a Zero Energy Building (ZEB) level or if cost limitations require nearly Zero Energy Building (nZEB). For the Danish situation, this means that the energy requirement for heating purpose is to be brought down from around 100 kWh/m<sup>2</sup> to below 20 kWh/m<sup>2</sup>. As the pilot project has not yet been identified, concept development calculations has been conducted for a generic building. The technologies to be considered for this energy renovation are: Insulation of the façade, insulation of the roof, low-energy windows, heat-recovery ventilation, solar domestic hot water and a PV-system. Within the MORE-CONNECT two technologies are under development in Denmark. The first is a new PV-roof solution in which the PV-cells are fully integrated in the roofing elements. This PV-roof can be fitted into any roof surface shape. It can also be constructed as a PVT-roof connected to a heat pump for heating purposes. The second technology under development is 3-D finishing of a new layer of façade insulation by an industry robot. When an insulation layer has been placed on any given façade a finishing layer of plaster can be added and finished with any desired patterns or painting.

The paper presents the present stage of the concept development work and is a continuation of the first concept development analysis presented at the SBE conference in Tallinn in 2016.

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## 1. Introduction

With 25% of the EU's energy consumption, energy savings in the residential building sector have been identified a key to achieve the EU's ambitious 2030 climate protection targets. A significant reduction of the carbon footprint requires the immediate implementation of a coherent nearly zero energy building (short: nZEB) strategy in the residential building stock.

Since the introduction of the EPBD numerous EU research projects have been creating a solid basis of innovative technology solutions for deep energy renovation of multi-family buildings by focusing on technology development, life-cycle cost assessment and demonstrations.

However, the rate of nearly zero energy renovation in the building sector is far beyond the necessary level to reach the overall CO<sub>2</sub>-emission reduction goals. In-stead of a required refurbishment rate of at least 2% only approximately 1% of the building floor space is currently undergoing energy renovation; unfortunately, in many cases building owners restrict their ambitions to the implementation of mini-mum energy requirements.

A deep energy renovation can also be referred to as a renovation leading to a near Zero Energy Building, which is the term used in the context of the EU MORE-CONNECT project [2]. This project includes demonstration of the developed technologies with six pilot projects in the different geo-clusters represented within the project. The goals and objectives of the MORE-CONCEPT project and the concept development methodology for the pilot projects are described in the following paragraphs.

### 1.1. Goals and quantitative objectives of the MORE-CONNECT project

The overall qualitative technological goals of the MORE-CONNECT project are:

1. The development of cost optimal deep renovation solutions towards nZEB concepts with the possibility of extra customize (cost-effective) features
2. The development and demonstration of prefabricated multifunctional modular renovation elements - in series of 1 - concepts, in a mass production process
3. The development and demonstration of new fully automated production lines for multifunctional modular renovation elements

The related quantitative objectives of MORE-CONNECT are:

4. Deep renovation toward NZEB, with a basic reduction of the primary energy consumption by at least 80 % compared to the original consumption.
5. New fully automated production lines with a cost/output optimization leading to >35% improvement compared to the traditional construction realization process.
6. Construction site workload reduced to less than 10% of the total workload of a retrofit compared to traditionally more than 50%.
7. Total installing time on site of with a maximum of 5 days with a final goal of 2 days.
8. Return of investment of less than 8 years for the end-user.
9. Construction failure costs reduced to less than 5% compared to the traditional 15 to 20%.

The work described in this paper relates to the first qualitative and the first quantitative objectives and aims at answering the question: How should a cost optimal deep energy renovation concept that reduces the primary energy consumption by 80% be put together out of the possible relevant energy saving and renewable energy technologies for the pilot buildings in question? The present paper accounts for a follow-up analysis to the first analysis carried out in the spring of 2016 and presented at the SBE conference in Tallinn [4].

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