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Converting Egyptian Commercial Building to NZEB using Low-Carbon Measures

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***Abstract* – The present work aims at analyzing the energy savings of the low-carbon retrofitting measures in an existing administration building as well as their economic feasibility. Atstarting, energy consumption analysis of an exemplary existing commercial building inCairo (Egypt) is carried out. Then, low-carbon measures in the considered building areapplied and evaluated. The low-carbon measures include both passive and active measuresto reach Net Zero Energy Building (NZEB). The exiting building energy consumption ofheating, cooling, ventilation, lighting, and appliances are analyzed using building simulationpackage, which consists of Sketchup, Open Studio and Energy Plus software under Cairoclimatic conditions. The simulated results are validated with the real energy consumption ofthe existing building. The yearly average deviation between the simulated results and thereal existing case is less than 1%. The economic feasibility of all implemented low carbonmeasures are conducted using the payback period. The reported results confirm thatconverting the existing administration buildings to NZEB is applicable under the Egyptiancircumstances using low-carbon retrofitting measures implementation and renewable energy (PV panel) systems installation.**

Keywords – commercial building; net zero energy building; low-carbon measures; cooling demand, building energy modeling and simulation.

I. INTRODUCTION

Decreasing energy consumption, carbon emissions and water usage are main keys toward better environmental sustainability. The increasing energy consumption and the accompanied greenhouse gas emissions are considered one of the greatest concerns recently.The total electricity demand in Egypt for the year 2018 reached 131.15 TWh with an annualaverage growth rate of 4.12%. The building sector alone contributes with 68% of totalelectricity demand in 2018 (EEHC, 2018).

In MENA region, the proposed energy saving strategies were applied on cases to develop the building regulations and energy codes (Hanna, 2010; Hanna and Physicist, 2006; Shamseldin, 2017). The National Energy Efficiency Action Plan (NEEAP) in Egypt targetsto apply 3 steps to reduce electrical energy consumption: efficient lamps (LED), efficientappliances and the encouragement to use solar water heaters (Elrefaei and Khalifa, 2014). Green pyramid rating system (GPRS) was developed for Egypt as a national environmentalrating system for buildings but it is not certified yet (Hanna, 2015). Using a model buildingsimulation tool and making sensitivity analysis to reduce the electric power consumption onpeak hours was carried by (Elharidi et al., 2013). The effect of implementing passive low-carbon measures on new buildings was studied theoretically in several studied. The shading, window glazing, air tightness and insulation can reduce energy consumption of an average of 33% (El-Darwish and Gomaa, 2017). Regarding active low-carbon measures, the high investment in the solar panels could be achieve a negative final energy balance and the feasibility of applying nearly zero energy building (nZEB) as a proposed solution for theenergy problem in New Borg El Arab City, Egypt (Reda et al., 2015). Solar panels could be used also in a hybrid renewable energy system to achieve a net zero energy village in Alexandria (Diab et al., 2015).

Accordingly, the national trend and the target of this phase is going to reduce the energy consumption in the buildings sector by applying the NZEB strategies to the newbuildings and refurbishment the already

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