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Building Integrated Photovoltaic Retrofitting in Office Buildings

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Abtract

The research main goal is to optimize the utilization of innovative renewable energy solutions focusing on the use of BIPV as an alternative to reduce dependency on fossil fuels and consequently reduce buildings carbon emissions.

A feasibility analysis of a building scale photovoltaic system retrofitting is conducted for an office building. A series of PV system options will be assessed in terms of the costs and projected energy production of several PV systems through renewable energy simulations modeling software, PVSOL premium. Different types of PV module and different types of mounting structure will be selected for the feasibility analysis based on an analysis of the current PV industry standards. Each system's output capacity (kW) will be calculated, annual energy output (KWh) and initial project cost for these different systems will then be modeled in PVSOL premium.

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Keywords: building integrated photovoltaic;retrofitting;office buildings.

1. Introduction

The extensive use of fossil fuels has increased the concentration of greenhouse gases around the Earth, resulting in the increase in global temperatures and environmental degradation. Energy conservation has become an urgent issue due to the depletion of fossil fuels and the increased concentration of carbon emissions. Great attention has to be made to reduce energy demand of office buildings through applying energy efficient measures and maximize energy usage

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produced by PV. The working hours of office buildings is suitable for the function of PV due to the fact that office buildings are mostly operational during daytime when the energy production from PV is high. Office buildings are often characterized by vast glazing facades

There is a great possibility of integrating renewable energy technologies in Egypt especially solar energy technologies. This suggests that much improvement has to be made to enhance the RE deployment and there is a need for more comprehensive approach and feasibility study to explore how to use existing RE technology to reduce fossil fuel energy consumption.

2. Retrofitting of office buildings

2.1. Need for retrofit

Today the increased demand for intelligent and dynamically responsive facades led the human thought away from the exaggerated cultural expressions that prevailed in architecture. Now the emphasis is on a facade that is climatically sensitive, sensibly reflecting local culture, while integrating innovative techniques to enhance the building's performance on various levels. These levels cover multilateral building aspects such as structural safety, energy consciousness, sustainability, and human psychological comfort. In order to compete with the desirability of new buildings and their provision of comfort, the existing stock is considered for retrofitting. Wigginton and Harris (2002) argue that considering buildings for retrofitting stems from a consciousness to allow buildings to strive for a state in which they were at the highest level of operational activity with the least expenditure on energy. Therefore, considering buildings for retrofitting is analogous to the biological system of evolution were survival is not only for the fittest but the non-survival of the unfit. Wigginton and Harris (2002) also warn against the naive assumption that developing nations will support and accept less comfort and commodities than the developed world has become accustomed to since the end of the nineteenth century. This increase in energy consumption will dictate not only an increase in energy production through renewables but on methods to reduce energy consumption and applying energy efficient measures by retrofitting the existing building stock.

2.2. Scale of retrofit

An enormous amount of energy is wasted because building equipment is operated improperly and unnecessarily. Rule of thumb is that they require a medium level refurbishment every 50-60 years and a major refurbishment every 120 year. At both break points, a decision has to be made as to whether the building is of sufficient quality to merit retrofit. For many modern buildings, due to life expectancy of building materials, the time of the first overhaul occurs much sooner than with traditional buildings-after 25-30 years rather than 50-60 years (Cowan 1962-63). From a structural dimension, (Highfield 2000) identifies six levels of building envelope retrofit.

(1) Retention of the entire existing building structure, together with its internal subdivisions, and upgrading of interior finishes, services and sanitary accommodations. In most low-key rehabilitation schemes, existing stairs would be upgraded in preference of installing lifts, and simple heating and cooling systems would be used, in conjunction with natural ventilation.
(2) Retention of the entire existing external envelope, including the roof, and most of the interior, with minor internal structural alterations (inserting elevators shafts, or altering staircases) and upgrading of interior finishes, services and sanitary accommodation.
(3) Retention of the entire existing external envelope, including the roof, with major internal structural alterations and upgrading of finishes, services and sanitary accommodation, but with major interior structural alterations such as insertion of new floors where the original storey height permits.
(4) Retention of all the building's envelope walls, and complete demolition of its roof and interior, with the construction of an entirely new building behind the retained facade.