Optimation of Energy Efficiency by Integrated Design of Folding Wall-BIPV and Users Behaviour in Office Building at Surabaya

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***Abstract*-Efficiency of BIPV measured by comparing electricity output and electricity demand. Electricity output generized by BIPV depends on the amount of solar radiation received by PV panel. Some factors that affect the amount of radiation received are the tilt angle and the orientation angle of PV panel. This research try to rise electricity output by collaborating this factor with orientation principle in folding concept. The collaboration results in bigger surface area to receive radiation. Meanwhile, the reducement of electricity demand will be described in relation with users behaviour, both individual behaviour and communal behaviour. As the object taken in this research is an office building, communal behaviour will take more impact to reduce energy demand. Policies and strategies related to energy efficiency made by central operational management in office building will control communal behaviour.**

***Keywords*-Annual radiation received; BIPV; folding wall; orientation; tilt; behaviour**

I. INTRODUCTION

Energy production commonly described as separated part from the built environment, with large scale power generation, and located some distance from the end user [1]. These cause a number of consequences, such as the lost of energy used in distribution progress and low awareness of the user from effects of the use to pollution, damage to local ecology, and intrusion into the landscape. Facing those kind of issues, architects are concerned to make a new concept of building design which can maximize the use of renewable energy, reduce energy demand, as well as being the energy source itself so it can produce energy in the nearest place to the end user.

Energy generation (heat or electricity) by individual buildings or small groups of buildings at the small scale can be defined as microgeneration. Microgeneration creates opportunities that bridges the divide between supply and demand, and also opportunities for consumers to become more aware of their energy use and its impacts [2]. Previous study of microgeneration and user behaviour in the UK domestic sector reported an estimated 6% reduction in overall electricity use and evidence was seen of an increase in general energy awareness and the use of efficient lighting [3]. This proves that users are no longer restricted to being passive recipients of electricity, but as potentially active participants that have contribution in determining the efficienct of microgeneration technology.

One of promising microgeneration technology is photovoltaic. PV panels produce the very high-grade energy of electricity, without any pollution, from abundant renewable resources, solarlight [4]. The direct benefits is clearly one of sustainable electrical power generation can make financial savings. Indirect benefits are more subtle and spand softer issues such as pride in building and increased users energy awareness. Efficiency of PV panels measured by output of electricity generation compared to electricity demand. In order to achieve higher efficiency, output of electricity generation should be higher and higher, while electricity demand should be lower and lower. High electrical demand should ideally be operated at the peak of solar day.

One of its system called BIPV (Building Integrated Photovoltaic) gives more advantages such as reducing cost. The use of PV panels as building envelope will substitute the need of conventional building's material. BIPV refers to the application of PV in which the system, as well as having the function of producing electricity, also takes on the role of building form and elements. One of interesting solution from BIPV application is the use of huge vertical facade in mid and high-rise building at urban area. In fact, the use of vertical facade is associated with the availability of huge vertical area compared to horizontal area (roof). The vertical installement might cause radiation supply is not maximal, but huge facade is expected to compensate power reduction.

The work of BIPV system as potential renewable technology depends on the amount of radiation that reach PV cell, factors related to PV cell, and factors related to architecture itself. The last means that the architecture form will influence the efficiency of BIPV, and BIPV will influence the form of architecture. One of architectural approach to create architecture forms is folding design. Folding architecture has the essence of orientation. In folding architecture, orientation can be arranged based on design needs [5]. Meanwhile, in BIPV the optimal orientation of PV panels take the big role in determining the output of electricity generation. Based on orientation principle in folding

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