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Optimization Energy Demand of Balinese Building for Tourist Green Accommodation I. D. M. Cipta Santosa* Mechanical Engineering Department Politeknik Negeri Bali, Kampus Bukit Jimbaran Bali, Indonesia *idmcsantosa@ppnb.ac.id I. G. A. G. Wiadnyana Mathematics Education Department Universitas PGRI Mahadewa Bali, Indonesia agunggedewiadnyana@gmail.com

Abstract—One of the main supports in the development of green tourism is green accommodation. In early, Balinese style building was designed with totally green concept with adequate natural environment. However, in recent years, Balinese style buildings considerable has weaknesses in terms of structure and materials very bad insulation for air conditioning loads. This study examines energy efficiency and conservation to reduce the energy demand for Balinese style buildings intended for tourist accommodation. As a case study, several accommodations in five tourist villages in the Badung regency-Bali were examined using a standard green building approach. Surveys and observations have been carried out on the existence of the accommodation in five tourist villages which are one of the supports for village tourism facilities. Data collection and analysis is carried out to obtain energy consumption saving strategies according to standards. From the analysis, it was found that the main energy demand is from air conditioning. So, to solve this problem through by setting control of the air conditioning which refers to environmental conditions. This setting still can reach the room comfort indicated by temperature and humidity. Keywords—Balinese building, green accommodation, energy demand

I. INTRODUCTION

At this time in modern countries there is general scientific agreement that about 30% 16 of the total energy use comes from the energy use of conventional buildings, so a systematic way is built to develop strategies for how to effectively green existing buildings. The findings conclude that using a strategy the green building can save energy in the range of 40% –60%. This high energy savings will contribute to a reduction in carbon intensity in the range of 20% –30%. The research undertaken is to convert existing buildings to green easily and cost-effectively, and with the efforts of each existing building to adopt a strategy, a very large effect will be anticipated in fighting global warming in return [1]. Bali as an international tourist destination, must

provide a lot of environmentally friendly accommodation. Another thing that is very worrying is the supply of conventional energy in the future, which is increasingly scarce and expensive, so the concept of building almost zero energy becomes very urgent to achieve. In previous research, the main aspects of the construction of the Bali Green Energy Building for hotel buildings (commercial building) were examined including VAC load control, occupant behavior, energy saving equipment / devices, renewable energy development, building aesthetics (architects) and energy considerations, as well as regulations and incentives. energy. Where this main aspect must be supported by a continuous building energy saving campaign to change the behavior of residents who care about energy conservation [2]. Residential building with the concept of green building has become an inevitable trend due to the implementation of Green Building Standards. Residential building schemes were analyzed through data analysis including quantity and floors, star level proportions and geographic distribution to determine the development status of green residential buildings. Meanwhile, the technology used in this scheme is divided into five categories namely Land Saving, Energy Saving, Water Saving, Material Saving and Indoor Environment in accordance with the Green Building Evaluation Standard. Combined with the cost of a particular technology, the relationship between frequently used technology and additional costs of various categories and star rates is discussed. So that we can optimize costs in the 1 application of green building for housing [3]. 8 Green Public Procurement (GPP) plays an important role in addressing the challenges of reducing the environmental impact of products, services and jobs associated with the construction sector, and creating environmental and innovative value for society that supports a greener and more sustainable economy. However, other essentials are missing and must be integrated to ensure green procurement initiatives. 6 This study critically reviews the proposed GPP criteria for office buildings and checks them against the sustainability indicators included in the BSA's three tools to strengthen the GPP framework for the office building sector. 2 It provides, on the one hand, an evaluation of the degree of improvement achieved in the tool when applying the GPP criteria and, on the

other hand, a proposal for a weighting system for awarding points to bids in tenders. 5 The results will help the contracting authority to introduce more objectivity into the tender process and to make informed decisions when evaluating bidder proposals [4]. 3 Advances in Engineering Research, volume 208 Proceedings of the International Conference on Innovation in Science and Technology (ICIST 2020) Copyright © 2021 The Authors. Published by Atlantis Press International B.V. This 1 is an open access article distributed under the CC BY-NC 4.0 license -http://creativecommons.org/licenses/by-nc/4.0/. 380

The energy saving sector can be seen from the main energy consumption in the building. both internal and external factors. The main internal factors are building construction and materials. They found that 21 the construction of residential buildings has a significant effect on the energy demand for air conditioning from air conditioners. The roof and walls cause height reinforcement totaling about 50-60% of the total heat gain in the building. So that the Balinese style building has weaknesses 1 in the form of walls and roofs that are not very good as insulation and with natural materials, especially from growing plants, especially weeds. The second internal factor is the operation of lighting 19 and HVAC (heating, ventilation and air conditioning), and the third is the number of occupants and occupant behavior. The external factors studied were the influence of climate and the surrounding environment on energy needs in buildings. So that with different climates and weather causes different conditions in air conditioning which causes differences in energy consumption for air conditioning [5-7]. Efforts to save energy and energy consumption in buildings are observed by the assessment or audit method. Efforts to save energy are carried out by designing control over the use of lights with the daylighting saving time method and reducing the peak electricity demand by 0.14%. Based on data from government buildings, commercial and household buildings, 20% energy savings are found, mostly from the air conditioning system. For industrial needs, it is also investigated by applying an automation system to lighting, heat recovery and door opening and 1 the

reduction of energy in power is obtained [8-10]. The adoption of renewable energy has been encouraged by several countries in recent years. Various modifications to solar technology (photovoltaic) are applied to buildings with a Building Integrated Photovoltaic (BIPV) system [11-13]. In Indonesia, this system will be very suitable because there is abundant sunlight throughout the year with a relatively high intensity and vice versa, air conditioning in buildings also requires a peak power source. For example, a commercial building has an energy consumption profile that is in line with the trend of daily solar radiation. Energy sourced from renewable energy can be combined with energy from the national grid. Based on this, it was found that photovoltaic (PV) technology is more profitable than wind energy technology. BIPV system is very useful to be applied especially in hot and sunny summer [14,15]. Some of the main obstacles in energy saving efforts are implementation constraints, conversion difficulties, lack of knowledge and information, lack of attention, expensive green building options, inadequate supervision, readiness of environmentally friendly products in the market, and absence of building management regulations [16]. They recommend that in solving the environmental resource crisis, government regulation will be effective to encourage greenhouse gas emissions from the building sector. Chack and Leung [17] introduced Greening the Existing Buildings (GEB), they provide a systematic way to develop strategies how 1 to reduce energy consumption. They found good performance with total energy savings in the range of 40-60%. Based on the previous studies described above, it can be concluded that green building is very urgent to be developed both in existing buildings and in new buildings. The green building concept developed in each area varies according to local conditions and conditions. For 1 a case study in Bali, which is a tourism destination, the existing buildings that use Balinese architecture with local materials need to be touched with the green building aspect for significant energy savings. So that this study will discuss and analyze the green building concept that is most suitable to the conditions to be able to significantly and sustainably reduce usage. II. METHODOLOGY This research is a series of process activities to create a green building model for application in Balinese stile

buildings in the tourism villages in Badung Regency, Bali, which will become a green destination. So that the local community can provide adequate accommodation by offering a green building concept even though they can still maintain the Balinese architectural concept, which in general has poor insulation in terms of air conditioning. The data was collected by means of surveys and observations combined with secondary data from the most recent journals. The research will be carried out in five tourism villages in the Badung Regency area as a case study to validate the development 1 of a green building model for the Bali stile building application. The data needed are primary and secondary data to perform in accordance with the real conditions of the building being the object. Primary data collection by conducting observations and surveys of accommodation buildings in the Tourism Village as a case study, by preparing detailed instruments based on green building standards developed by GREENSHIP [18]. The survey was conducted using questionnaire instruments, resident appraisals, from various parties, starting from the community, tourism residents, and the government as the regulator. Samples were taken randomly with the on-line or paper-based filling method. Data collection is also carried out by collecting bill data or payment of electricity and water consumption per month from tourism accommodation in the villages concerned and residents' houses that are potentially used for tourism accommodation. This is followed by an energy assessment of several samples of tourism accommodation. Meanwhile, the appraisal to measure the comfort of the accommodation was carried out by the appraisal indoor comfort perception of each sample of tourism accommodation. Where this appraisal is combined with measurements of room temperature and tolerability which further valid instruments will be made. Meanwhile, secondary data was obtained from journals and other previously published references as well as data from the Bali Province BPS, as well as additional data from each tourist village. The method of data analysis is carried out with statistics which can be shown in pictures, graphs and tables. Meanwhile, for instrument and model validation, valid instruments with expert validation will be prepared. 3 Advances in Engineering Research, volume 208 381

III. RESULTS AND DISCUSSIONS This article discusses efforts to reduce energy demand from the operational side of air conditioning which is analyzed from outdoor environmental conditions and occupant comfort appraisals. However, from the perspective of other energy use such as lighting and hot water for bathing, the same as other building concepts. a comprehensive analysis of green building standards will be investigated further. The results and discussion are described below. A. Building Energy Assesment In this study, the observation of the condition of tourism accommodation in each tourist village. From the case study, it was found that the minimum facilities for one tourism accommodation consist of one bedroom, one kitchen, one bathroom and one private swimming pool. Each of these facilities has the main electronic equipment, namely: air conditioning, water heater, refrigerator, light and pool pump, as shown in Figure 1. In general, the energy saving method in tourism village accommodation is recommended to be carried out in four ways, namely: (1) Socialization and campaigns to support Inhabitants behavior for residents who support the "save energy" program by providing signings at each accommodation facility, (2) Control the operational setting of the room's air conditioning system, (3) Operational water heater or choose a low wattage water heater and (4) choose energy-efficient electronic equipment (low energy appliances/ devices). Fig. 1. Devices of the tourism accommodation. From the methods recommended in this study, the focus is on the study of the control setting for the air conditioning system, because the dominant energy requirement for this accommodation is the use of an air conditioning system. Besides that, other methods are very practical to be implemented. A simple statistical assessment is shown in the graph of the daily average energy demand for one accommodation, from the greatest to the smallest needs shown in Figure 2. Fig. 2. Daily energy demand of de4vices. From Figure 2 above, it is clear that the use of air conditioning is very wasteful, this is a strong rational for reducing energy demand in this system. And it seems that it is also caused by the habitual factors of residents who are still not aware of the operations of the air conditioning system. B. Analysis of Indoor and Outdoor Condition In this study, data

obtained from an appraisal survey on the comfort aspect of residents consisting of local residents and foreign tourist with 1 a case study of five Tourism Villages which are the main tourist destinations in the northern part of Badung Regency. Given that in the south, such as Kuta, Nusa Dua, Jimbaran, etc., which have become very crowded destinations and have developed into mass tourism. Meanwhile, the accommodation developed in these villages is all with a very thick Balinese architecture 1 as shown in Figure 3 below. It can be seen that building materials are local materials that have been used since ancient times, mainly namely: roofs of grass, wood, or tiles with lots of ventilation and glass windows (each side) to get a beautiful view of the environment. The walls are made of brick and thinly plastered so that they have low thermal resistance. The doors and windows are all made of local wood. From the analysis of these materials, from the load aspect, air conditioning is a material that has low thermal resistance so that the insulation of the building in terms of air conditioning is very bad, but in terms of aesthetics, Balinese architecture must be maintained and preserved. Thus, an innovative energy saving strategy is needed. 3 Advances in Engineering Research, volume 208 382

Fig. 3. Balinese style building with local material. With regard to environmental data, Figure 4 shows the mean temperature at the five village locations as 1 a case study. In general, it is found that July is the coldest month while March and November are the hottest months. The lowest annual average temperature is 22 oC and the highest temperature is 31.7oC with humidity ranging from 80% to 90%, and the higher the position of the sea level, these tourist villages have cooler temperatures and higher humidity. Fig. 4. Annual outdoor temperature at five villages in case study. C. Analysis of Thermal Confort Appraisal In this study, data obtained from an appraisal survey about the comfort of residents consisting of local residents and foreign tourist residents with 1 a case study of five tourist villages in Badung Regency which are the main tourist destinations. This is due to the adjustment of the residents because most of them do outdoor activities when traveling in the villages. Obviously, because the tourist destinations in these villages are

natural tourism with beautiful panoramic views of rice fields, rivers and farming area which is equipped with the availability of outbound facilities. So that when you are in the room you will feel comfortable if the temperature and humidity are kept slightly below the outdoor temperature. Another thing that the comfortable concept is introduced in this study. To achieve comfort condition is reach by the dew point temperature parameter, so that air conditioning system can reduce room humidity. Where the dew point calculation is shown in Table1. For instance, when ambient temperature is 28oC and humidity of 85% , obtained a dew point of 26 oC. So that by setting the temperature to 26oC, the air conditioning is able to provide good comfort for the air in the room. While in general the comfort of ASHRAE version [19] is a comfort condition in the temperature range of 24oC and 60% humidity. This condition is a general condition called the comfort zone where the temperature can range from 22 oC -26 oC with humidity ranging from 40% to 70%. This is because of condition an optimum rate of heat and mass dissipation occurs from the human body to the environment. Even though in fact each person has different comfort opinion. TABLE I. APPRAISAL OF COMFORT PERCEPTION No Villages as case study Average outdoor condition (observation) Dew Point Indoor comfort appraisal Temperature and humidity Temp (oC) RH (%) oC oC/%RH 1 Mengwi 28 85 26 25oC/65% 2 Sangeh 27 85 25 25oC/65% 3 Bongkasa Pertiwi 25 90 24 24oC/65% 4 Pangsan 24 95 23 24oC/65% 5 Plaga 23 95 22 24oC/65% From the results in table 1 of the appraisal analysis above, to achieve the level of comfort it is focused on reducing humidity so that it is set at the dew point temperature. Thus, an effective reduction in energy demand can be obtained. For conventional air conditioning, the temperature is lowered only around 1oC- 2oC from the ambient temperature. From empirical data it is stated that by increasing the temperature by 1oC it can save energy by 6%, so that if it is set from 18oC to 24oC it can save power by 24%. IV. CONCLUSIONS From the previous description, it can be concluded that the energy demand can be reduced in terms of optimizing the use

of air conditioning. This is done because energy for air conditioning is dominant for the building. As Balinese stile buildings have poor insulation from the cooling load side, this is what causes the air conditioning load to be very high due to high infiltration. Recommendations suggested to accommodation managers with Balinese style buildings to achieve the standard of green accommodation are energy reduction accompanied by energy- saving behavior from residents, and the use of clean photovoltaic energy to approach the achievement of building zero net energy. ACKNOWLEDGMENT This study was supported by the Bali State Polytechnic (Politeknik Negeri Bali) for the in-cash contribution. The authors wish to acknowledge the contributions of Mechanical Engineering Department - Bali State Polytechnic for the in- kind contributions, also Centre for Research and Community Service (P3M) for all administrative support. REFERENCES [1] B.C.M. Leung, “Greening existing buildings [GEB] strategies”, Energy Reports, Vol. 4 , pp.159–206, 2018 . [2] I.D.M.C.Santosa, M.E.Arsana, “Balinese green building model emphasizing on criteria of energy efficiency and conservation”, Journal of Physics Conference Series, 2020. [3] F. Xu, N. Xie, J. Zhou, K. Yin, B. Wang, “Study on developing status and appropriate technologies analysis of green residential buildings in Hunan province”, Energy Procedia, Vol. 121, pp. 150–157, 2017. [4] M. Braulio, Gonzalo, M. D. Bovea, “Relationship between green public procurement criteria and sustainability assessment tools applied to office buildings”, Environmental Impact Assessment Review, Vol. 81, pp. 106310, 2020 [5] J. C. Lam, K.K.W. Wan, C.L.Tsang C L and L.Yang, “Building energy efficiency in different climates”, Energy Conversion and Management, Vol. 49, pp. 2354–2366, 2008. [6] A. Utama and S.H Gheewala, “Influence of material selection on energy demand in residential houses”, Materials and Design, Vol. 30, pp. 2173– 2180, 2009. [7] H.X. Zhao and Z. Magoulès, “A review on the prediction of building energy consumption”, Renewable and Sustainable Energy Reviews, Vol. 16, pp. 3586-3592, 2012. [8] M. Krarti and A. Hajiah,”Analysis of impact of daylight time savings on energy use of buildings in Kuwait”, Energy Policy, Vol. 39, pp. 2319– 2329, 2011. [9] A. Roslizar , M.A. Alghoul, B. Bakhtyar , N. Asim and K. Sopian, “Annual Energy Usage Reduction and

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