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**Program**

**Thursday, September 27**

**Thursday, September 27 9:30 - 11:30**

**INV: Invited Paper**

*Green Computing: Opportunity of Using Breadth Fixed Gossip Algorithm for Optimizing Power Supply Route in Power Plant*

Mauridhi Purnomo (Institut Teknologi Sepuluh Nopember, Indonesia)

pp. 1-6

**Thursday, September 27 13:00 - 15:15**

**A1: Electronic Circuit & Control**

*Magnetic Field Relationship between Distance and Induced Voltage Generated by EMP*

Betantya Nugroho and Azil Yahya (Universiti Teknologi Malaysia, Malaysia); Abd Rahim (Mindmatics, Malaysia); Trias Andromeda (Universitas Diponegoro, Indonesia)

pp. 7-10

*Communication Protocol on 64-Channel ECVT Data Acquisition System*

Arbai Yusuf (Universitas Indonesia & C-Tech Labs Edwar Technology, Indonesia)

pp. 11-14

*Cooling System Design Based on Thermoelectric Using Fan Motor on-off Control*

Munnik Haryanti (Universitas Dirgantara Marsekal Suryadarma, Indonesia)

pp. 15-18

*Design of The 3D Surface Scanning System for Human Wrist Contour Using Laser Line Imaging*

Riky Tri Yunardi and Ario Imandiri (Universitas Airlangga, Indonesia)

pp. 19-23

*Temperature Controlling Using PID Controller on Rice Grain Fluidized Dryer Prototype*

Aris Triwiyatno (Diponegoro University, Indonesia)

pp. 24-27

*PID Based Air Heater Controller Implemented With Matlab/Simulink and Arduino Uno*

Bambang Supriyo, Dadi Dadi, Sulistyowarjono, Adi Wisaksono, Sri Astuti and Kusno Utomo (Politeknik Negeri Semarang, Indonesia)

pp. 28-32

*Design A Low Cost Wind Direction Sensor With High Accuracy*

Yoga Utama (University of Widya Kartika, Indonesia)

pp. 33-38

*Quadruped Robot with Stabilization Algorithm on Uneven Floor using 6 DOF IMU based Inverse Kinematic*

Rofiq Prayogo (Diponegoro University, Indonesia)

pp. 39-44

*Design and Characterization of Low-Cost Soft Pneumatic Bending Actuator for Hand Rehabilitation*

Mohammad Arifianto, Joga Setiawan, Rifky Ismail, Ismoyo Haryanto, Tania Febrina and Doni Saksono (Diponegoro University, Indonesia)

pp. 45-50

**B1: Electric & Power System**
D1: Telecommunications & Radio Frequency

Study on 2G Termination in Indonesia using BCG Matrix
Ailand Fadlan and Abij S. Ariffin (Universitas Indonesia, Indonesia)
p. 147-151

Performance of BFSK base on PACTOR I protocol over AWGN channels
Mohd Yazid Ab Razak (National University of Malaysia & Mindmatics Sdn. Bhd., Malaysia); Abd Rahim Mat Sidek (Mindmatics Sdn. Bhd., Malaysia); Nazrul Ariffin (Universiti Kebangsaan Malaysia, Malaysia)
p. 152-156

Development of Radio Direction Finder using 6 Log Periodic Dipole Array Antennas
Kartiko Nugroho, Azl Yahya and Nor Hisham Khamis (Universiti Teknologi Malaysia, Malaysia); Nuramirah Mohd Nor (Mindmatics Sdn. Bhd., Malaysia); Mohd Yazid Ab Razak (National University of Malaysia & Mindmatics Sdn Bhd, Malaysia)
p. 157-160

Directional 2x2 MIMO Microstrip Antenna Design and Optimization for LTE Band-3 Application
Tommi Hariyadi and Rizky Megantara (Universitas Pendidikan Indonesia, Indonesia)
p. 161-165

High Throughput Wireless Printer Server based on IEEE 802.11n
Wahyu Amien Syafei (Diponegoro University, Semarang & Kyushu Institute of Technology, Japan); Imam Santoso (Diponegoro University, Indonesia); Sudarmawan Sudarmawan (AMIKOM Yogyakarta University, Indonesia); Kartika Santoso (STMIK Bina Patria, Indonesia); Muhammad Muin (Universitas AMIKOM Yogyakarta & STMIK Bina Patria, Indonesia); Arief Setyanto (Universitas AMIKOM Yogyakarta, Indonesia)
p. 166-170

Analysis of Batik Water Waste Monitoring System based on LoRa Communication
Michael Stephen Moses Pakpahan, Eko Didik Widiandto and Risma Septiana (Diponegoro University, Indonesia)
p. 171-175

C1: Information & Computer Technologies

MRI Image Segmentation using Morphological Enhancement and Noise Removal based on Fuzzy C-means
Robert Setyawan, Mustofa Aliashid Almanhudi, Christy Atika Sari, De Rosal Ignatius Moses Setiadi and Eko Hari Rachmawanto (Dian Nuswantoro University, Indonesia)
p. 99-104

Measurement on Real-Time Diagnostico of Gastric Tumor Model Using Wireless Endoscopy System
Novitasari Chismanandini (University of Indonesia, Indonesia); Arie Pangestu Aji (Universitas Indonesia, Indonesia); Yudhiansyah Yudiansyah (University of Indonesia, Indonesia); Prita Dewi Maniary, Juhanal Fuadi, Yulianto La Eio and Basari Basari (Universitas Indonesia, Indonesia)
p. 105-108

Relational Database Structure and Operations Engineering Based on UML Diagram
Lukman Hakim (Bandung Institute of Technology, Indonesia); Sukrisno Mardiyanto (Institut Teknologi Bandung, Indonesia)
p. 109-113

Design of Secure IoT Platform For Smart Home System
Arvandy Arvandy and Yoanes Bandung (Institut Teknologi Bandung, Indonesia)
p. 114-119

Marker Image Variables Measurement of Augmented Reality in Mobile Application
Ike Wondasari, Yudi Windarto and Risma Septiana (Diponegoro University, Indonesia)
p. 120-124

Sentiment Analysis and Topic Modelling for Identification of Government Service Satisfaction
Moh Nazrul Aziz, Azr Firmanto, Ahmad Miftah Fajrin and R. V. Hari Ginardi (Institut Teknologi Sepuluh Nopember, Indonesia)
p. 125-130

Prototype of Online Examination on MoLearn Applications using Text Similarity to Detect Plagiarism
Mohd Yazid Ab Razak (National University of Malaysia & Mindmatics Sdn. Bhd., Malaysia); Abd Rahim Mat Sidek (Mindmatics Sdn. Bhd., Malaysia); Nazrul Ariffin (Universiti Kebangsaan Malaysia, Malaysia)
p. 131-136

Performance Comparison Between AES256-Blowfish and Blowfish-AES256 Combination
Muhammad Hafiz (Universitas AMIKOM Yogyakarta & STMIK Bina Patria, Indonesia); Arief Setyanto (Universitas AMIKOM Yogyakarta, Indonesia); Sudarmawan Sudarmawan (AMIKOM Yogyakarta University, Indonesia); Kartika Santos (STMIK Bina Patria, Indonesia)
p. 137-141

A Natural Childbirth Training Simulation in Virtual Environment For Prospective Midwife
Alvin Nugraha, Aulia Faza, Wulan Indayani and Hanny Haryanto (Universitas Dian Nuswantoro, Indonesia); Abas Setiawan (Dian Nuswantoro University, Indonesia)
p. 142-146
A GIS-based Waste Water Monitoring System Using LoRa Technology
Yudi Windarto and Agung Prasetijo (Diponegoro University, Indonesia); Galang Damara (Universitas Diponegoro, Indonesia)
pp. 176-179

Filtering for Data Acquisition on Wireless Sensor Network
Aghus Sofwan, Sumardi Sumardi and Nely Uliwiyati (Diponegoro University, Indonesia)
pp. 180-184

Thursday, September 27 15:30 - 17:30

A2: Electronic Circuit & Control

Predictive Control for Relative Performance Management
Dharma Aryani (State Polytechnic of Ujong Pandang, Indonesia); Nur Asyik Hidayatullah (State Polytechnic of Madiun, Indonesia)
pp. 185-190

Design and Development of Injection Current Control On Inverter-Based Proportional Resonant Method
Abdul Haris Kusrananto (Universitas Diponegoro, Indonesia)
pp. 191-196

Development of Object Tracking System Using Remotely Operated Vehicle Based on Visual sensor
Erwin Saputra and Ronny Mardiyanto (Institut Teknologi Sepuluh Nopember, Indonesia)
pp. 197-202

Predictive Control Approach for Restricted Areas Avoidance of Autonomous System
Sutrisno Sutrisno, Widowati Widowati, Sunarsih Sunarsih and Kartono Kartono (Diponegoro University, Indonesia)
pp. 203-207

Kufarm: A Modified Platform of Automation Planting System
Damar Pramuditya (Telkomuniversity, Indonesia); Agung Nugroho Jati and Fairuz Azmi (Telkom University, Indonesia)
pp. 208-213

Tracking Object based on GPS and IMU Sensor
Wahyudi Wahyudi (Department of Electrical Engineering, Diponegoro University, Indonesia)
pp. 214-216

Development of Navigation Method of Buoyant Boat for Maintaining Position of The Boat and ROV
Ronny Mardiyanto, Heri Suryoatmojo and Badrun Tamam (Institut Teknologi Sepuluh Nopember, Indonesia)
pp. 217-222

Development of a Low-Cost Quadrupedal Starfish Soft Robot
Mochammad Ariyanto, Munadi M and Joga Setiawan (Diponegoro University, Indonesia)
pp. 223-228

Performance Improvement of Robot Warehouse Based on Battery Operational Conditions
Alima Budiyanto, Aris Setiawan and Setyawan Wahyu Pratomo (Universitas Islam Indonesia, Indonesia)
pp. 229-233

B2: Electric & Power System

Design of Adaptive PID Controller for Fuel Utilization In Solid Oxide Fuel Cell
Darjat Darjat, Sulistyowati Sulistyowati and Aris Triwiyatno (Diponegoro University, Indonesia)
pp. 234-239

Study on Photovoltaic Hosting in Yogyakarta Electric Distribution Network
Faisal Fuad Rahman Soeharto (Universitas Gadjah Mada, Indonesia); Kristanto Adi Widiatmoko and Sarjya Sarjya (Gadjah Mada University, Indonesia); Lesanto Multa Putranto (UGM, Indonesia)
pp. 240-244

Analysis of grounding System in 150 kV Kudus Substation
Izza Pratama (Diponegoro University, Indonesia)
pp. 245-250

Maximum Power Tracking of Solar Panel using Modified Incremental Conductance Method
Trias Andromeda (Universitas Diponegoro, Indonesia); Betanya Nugroho (Universitas Gadjah Mada, Indonesia); Azli Yahya (Universitas Teknologi Malaysia, Malaysia); Hermanwan Hermawan and Mochammad Facta (Diponegoro University, Indonesia); Iwan Setiawan (Diponegoro University, Indonesia)
pp. 251-256

Electrical Load Forecasting Study Using Artificial Neural Network Method for Minimizing Blackout
Husein Mubarok and Mukhamad Sapanta (Universitas Islam Indonesia, Indonesia)
pp. 257-260

Comparison Study on Leakage Current of 20 kV Silicone Rubber and Epoxy Resin Insulator Under Dry and Wet Condition
Taryo Tarvo (Diponegoro University, Indonesia); Abdul Syakur (Universitas Diponegoro, Indonesia); Herrawan Herrawan (Diponegoro University, Indonesia)
pp. 261-263

Leakage Current Characteristics of 20 kV Epoxy Resin Insulators Under Variation Humidity
Periwi Utami and Herrawan Herrawan (Universitas Diponegoro, Indonesia); Abdul Syakur (Universitas Diponegoro, Indonesia)
pp. 264-267

Measurement System for Surface Leakage Current at Epoxy Resin Insulating Materials
Abdul Syakur (Diponegoro University, Indonesia); Wahyudi Wahyudi (Departemen Teknik Elektrik UNDIP, Indonesia); Jumrianto Jumrianto, Jr (Diponegoro University & NET TV, Indonesia)
pp. 268-271

An Investigation of Direct Grounding Effect on Modeling of Lightning and Tower in Transmission Line
Agung Nugroho, Omar Abouzeid, Mochammad Facta, Karnoto, Abdul Syakur and Herrawan Herrawan (Diponegoro University, Indonesia)
pp. 272-275

C2: Information & Computer Technologies

Halstead Metric for Quality Measurement of Various Version of Statcato
Iwan Binanto (Sanata Dharma University, Indonesia); Bahtiar Saleh Abbas and Nesti Sianipar (Bina Nusantara University, Indonesia); Harco Leslie Hendic Spits Warnars (Bina Nusantara University & Doctor of Computer Science, Indonesia)
pp. 276-281

Environmental Health Monitoring with Smartphone Application
Kodrat Iman Satoto, Eko Didik Widianto and Sumardi Sumardi (Diponegoro University, Indonesia)
pp. 282-286

Two-Step Ranking Document Using the Ontology-Based Causality Detection
A. A. I. N. Eka Karyawati and L. A. A. Rahning Putri (Universitas Indonesia, Indonesia)
pp. 287-292

Knowledge Management Model in Syariah Banking
Nurdin Nurdin (Institut Agama Islam Negeri Palu); Sagaf S Pettalongi and Khaeruddin Yusuf (Institut Agama Islam Negeri Palu, Indonesia)
pp. 293-298
Energy Saving Measures and Potential of Energy Efficiency at the University of Surabaya, Based on EDGE Simulation

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Abstract—Higher education institutions play an essential role in promoting and developing sustainability. Implementation of energy efficient technology would reduce the amount of energy used significantly, in particular in buildings. The energy saving measures and potential for energy efficiency for a university campus are discussed and simulated in this paper. The simulation was done based on the parameters in EDGE (Excellence in Design for Greater Efficiency) simulation software. There are nine measures that can be done without significant building renovation. Yet those changes still affect significantly to the energy efficiency if done simultaneously. The total energy savings that can be obtained by doing all those nine changes is 18.9%. This improvement will give operational carbon savings 769.78 tCO2/year.

Keywords—energy saving, energy measure, energy efficiency University of Surabaya

I. INTRODUCTION

Energy issue has been one of the primary issues, along with an environment, food, and population[1][2]. Energy consumption has increased at a rapid rate, by means of extracting and combusting of fossil fuels. This situation causes environmental problems, particularly related to the global warming and climate change [3][4][5]. Studies indicated that the implementation of energy efficient technology would reduce the amount of energy used significantly, in particular in buildings[6].

Implementation of energy efficiency plan would reduce energy consumption. There have been few studies of identifying the measures for energy saving. However, it is obviously seen that the potential to implement energy saving measures exists [3]. Many Attempts to seize the energy efficiency opportunity, accelerating the deployment energy saving measures have been made through: supporting innovation of energy efficiency; connecting technologies and knowledge on energy efficiency to finance feasible returns; harnessing the information on the power improvement of energy use of, driving its disclosure and availability; and encouraging action [7].

Higher education institutions such as universities, play an important role in promoting and developing sustainability. A university has the responsibility to integrate sustainable development into all its operations [1]. The University of Surabaya is one of the prime universities in the eastern area of Indonesia. From previous research it was revealed that, along with the development of the campus, the need for electrical energy in this university continues to increase every year. On the other hand, the results also detect a number of opportunities for electricity savings [8]. The management of the university has a high concern for energy saving issues. This study discusses the energy measures and simulates the energy savings potentials in the University of Surabaya (Ubaya) campus. The objective of the study is to find the most feasible way of energy efficiency. It is expected that the results from this study would be useful and applicable for scaling up to a wider scope energy efficiency.

II. METHODS

For the first step, an analysis of the current conditions is performed. Based on the number of active students and campus area, it can be calculated that the occupancy density is 3 m²/student. Campus operational in accordance with the provisions is 8 hours per day, 5 working days per week, and about 60 national holidays per year. These data are used as inputs on the EDGE software to calculate the current conditions as the baseline.

Software to run this simulation study is so called EDGE (Excellence in Design for Greater Efficiency), provided by IFC, group of World Bank and open for public use. An account needs to be created (at the website : https://app/edgebuildings.com) [9] prior to full access and utilization of the system. The software enables to assist stakeholders in designing a resource efficient building. Several applicable parameters are included and can be simulated based on local condition resulting in measurable and comparable resource utilization for buildings.

This software has three components representing the resource used in a building; those are energy, water and material components. The system is able to calculate the amount of resource used in a building, and by simulating several parameters, comparison of several options can be
made. Thus, the utility saving can be described. Moreover, EDGE software also able to measure reduced carbon footprint following the utility saving pattern. However, in this study simulation study was conducted with a focus on energy measures for all building in the campus area. Detail information regards to the energy utilization has been collected and used to run the software. Some parameters (system/solution) in the program had been chosen based on the current condition in the University and simulated in order to find the most feasible option for energy efficiency scenario.

III. RESULTS AND DISCUSSIONS

The object of this simulation study is all buildings in the campus area of the University of Surabaya, which is located in Jalan Raya Tenggilis, Surabaya, East Java. With a total area of nearly 14 hectares, there are 29 permanent buildings for various functions such as classroom, laboratory, library, administration office, and cafeteria. All buildings are typically constructed from brick and plaster, but differ in number of storey. The abbreviations is used for building names, represent the name of each building; the first letter describes the name of faculty in which the building belongs to, for example, P for Psychology, E for Economic, and T for Engineering (Teknik in Bahasa Indonesia). Therefore TA refers to building A of Faculty of Engineering, FA refers to building A of Faculty of Pharmacy (Farmasi in Bahasa Indonesia) and so on. This abbreviation system is not applied for common purpose building (eg. International Village, Library, Canteen/Cafeteria). Typical building is as shown in Figure 1., meanwhile the number of storey in each building that is included in this study is provided in Table 1 [10].

Electricity for all buildings is supplied by National Electricity company (PLN) and used mainly for lighting and cooling purposes. For lighting, all building use fluorescent (FL) type of lamp; as for cooling most of building use non-centralized cooling system – only library building uses centralized system. Electricity is turned on during working hours, 08.00 – 17.00, except for Library, which is operated 08.00 – 19.00 daily.

With the current campus condition applying 5 working days with a total of 40 working hours per week and the occupancy density is 3 m²/person, it appears that the largest energy absorption is used for air conditioning systems. This condition is used as a base case in this study. This base case is generated from the software by entering the basic parameters that correspond to the real conditions. Furthermore from the base case will be simulated changes that can be made according to EDGE measurement indicators to estimate energy efficiency.

The simulation results from EDGE software are shown in Table 2. It shows the codes, the referred measures, and energy savings gained when applying the corresponding measures. There are 2 measures that give an energy efficiency impact of more than 10%, i.e. EDE05 and EDE10. EDE05 requires a significant reshuffle on the roof of every building. Meanwhile EDE10 will affect the comfort of indoor activities. Therefore those two measures are not recommended.

There are several measures that can be done without significant building renovation. Yet those changes still affect significantly to the energy efficiency if done simultaneously. Those are the use of reflective paint on the roof and walls (EDE02 and EDE03), the addition of external shading devices (EDE04), the use of energy-efficient bulbs

![Fig. 1. Typical Building of University of Surabaya](image-url)
in all campuses areas (EDE23 and EDE24), occupancy sensors in all indoor areas (EDE25, EDE26 and EDE27), and photoelectric sensors to harvest daylight (EDE28). EDE02 and EDE03 together will provide an energy saving impact of 6.6%. EDE04 contributes 3% energy savings. Use of energy-saving lamps will save energy by 2.9%. While the overall use of the sensor will save energy by 9.3%. The total energy savings that can be obtained by doing all those nine changes is 18.9%. This figure is very close to the standard set by EDGE of 20%. The comparison between the base case and improved case are shown in figure 2. The improved case is the one that applies all those nine measures which give 18.9% energy efficiency. In this case, it will save energy around 280 MWh/year. Since the current electricity demand is fully obtained from the state power company whose majority of the energy source is still from fossil fuel, this efficiency will also contribute to reducing CO₂ emissions. Assuming a reduction in emissions of 0.6 kg.CO₂/kWh, these improvements will give operational carbon savings about 769.78 tCO₂/year.

![FIG. 2. Energy Saving Comparison between Based Case and Improved Case](image)

**TABLE 2. SIMULATION RESULT OF ALL ENERGY SAVING MEASURES**

<table>
<thead>
<tr>
<th>Code</th>
<th>Measure</th>
<th>Energy Saving (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EDE01</td>
<td>Reduced Window To Wall Ratio</td>
<td>3.1</td>
</tr>
<tr>
<td>EDE02</td>
<td>Reflective Paint/Tiles For Roof</td>
<td>6.1</td>
</tr>
<tr>
<td>EDE03</td>
<td>Reflective Paint For External Walls</td>
<td>0.5</td>
</tr>
<tr>
<td>EDE04</td>
<td>External Shading Devices</td>
<td>3</td>
</tr>
<tr>
<td>EDE05</td>
<td>Insulation Of Roof</td>
<td>13</td>
</tr>
<tr>
<td>EDE06</td>
<td>Insulation Of External Walls</td>
<td>1.7</td>
</tr>
<tr>
<td>EDE07</td>
<td>Low-E Coated Glass</td>
<td>1.7</td>
</tr>
<tr>
<td>EDE08</td>
<td>Natural Ventilation For Corridors</td>
<td>0.9</td>
</tr>
<tr>
<td>EDE09</td>
<td>Natural Ventilation For Classrooms</td>
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</tr>
<tr>
<td>EDE10</td>
<td>Ceiling Fans In All Classrooms</td>
<td>15.8</td>
</tr>
<tr>
<td>EDE11</td>
<td>Variable Refrigerant Volume (Vrv) Cooling System</td>
<td>-7.9</td>
</tr>
<tr>
<td>EDE12</td>
<td>Air Conditioning With Air Cooled Chiller</td>
<td>-13.1</td>
</tr>
<tr>
<td>EDE13</td>
<td>Air Conditioning With Water Cooled Chiller</td>
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</tr>
<tr>
<td>EDE14</td>
<td>Ground Source Heat Pump</td>
<td>-8.1</td>
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<tr>
<td>EDE15</td>
<td>Absorption Chiller Powered By Waste Heat</td>
<td>7.2</td>
</tr>
<tr>
<td>EDE16</td>
<td>Recovery Of Waste Heat From The Generator For Space Heating</td>
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</tr>
<tr>
<td>EDE17</td>
<td>Variable Speed Drives On The Fans On Cooling Towers</td>
<td>0.8</td>
</tr>
<tr>
<td>EDE18</td>
<td>VARIABLE SPEED DRIVES IN Altas</td>
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</tr>
<tr>
<td>EDE19</td>
<td>Variable Speed Drive Pumps</td>
<td>-0.5</td>
</tr>
<tr>
<td>EDE20</td>
<td>Sensible Heat Recovery From Exhaust Air</td>
<td>7.4</td>
</tr>
<tr>
<td>EDE21</td>
<td>High Efficiency Condensing Boiler For Space Heating</td>
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</tr>
<tr>
<td>EDE22</td>
<td>High Efficiency Boiler For Water Heating</td>
<td>0</td>
</tr>
<tr>
<td>EDE23</td>
<td>Energy Saving Light Bulbs For Internal Spaces</td>
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<tr>
<td>EDE24</td>
<td>Energy Saving Light Bulbs For External Areas</td>
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<td>EDE25</td>
<td>Occupancy Sensors In Bathrooms</td>
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<tr>
<td>EDE26</td>
<td>Occupancy Sensors In Classrooms</td>
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<tr>
<td>EDE27</td>
<td>Occupancy Sensors In Corridors</td>
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<tr>
<td>EDE28</td>
<td>Photoelectric Sensors To Harvest Daylight</td>
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</tr>
<tr>
<td>EDE29</td>
<td>Solar Hot Water Collectors</td>
<td>4.7</td>
</tr>
<tr>
<td>EDE30</td>
<td>Solar Photovoltaics</td>
<td>Depend on the annual electricity gained</td>
</tr>
<tr>
<td>EDE31</td>
<td>Other Renewable Energy For Electricity Generation</td>
<td>Depend on the annual electricity gained</td>
</tr>
</tbody>
</table>

91
IV. CONCLUSION

The simulation studies show that by applying the combination of nine measures of 31 measures of energy saving in the simulation would result in the total energy efficiency of 19% for buildings of the University of Surabaya. The measures refer respectively to: the use of reflective paint on the roof and walls, the addition of external shading devices, the use of energy-efficient bulbs in all campuses areas, occupancy sensors in all indoor areas, and photoelectric sensors to harvest daylight. The implementation of the measures will give operational carbon savings 769.78 tCO2/year. However, energy efficiency for existing building could be attempted by many ways.

REFERENCES


