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Energy Recovery Model Through Condenser Unit of Split Type Air Conditioner

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Abstract. This study represents a technology for generating power using non-natural wind (wind exhaust system). To generate electricity, a vertical axis wind turbine (VAWT) in crosswind orientation was put on a air conditioner system. The ADDIE model was used to create this system. Experiments were conducted to evaluate the VAWT's performance. To test the performance of VAWT, a prototype structure was created first. The winds used are from a 1 horsepower air conditioner condenser unit with a 400 mm diameter wind exit. The optimal horizontal position is 160 mm from the centre of the wind outlet, whereas the best vertical position is 50 mm. The power generated in this setup was 0.46 watts. The time it takes to fully charge a battery from zero for the supporting battery and the primary battery, according to theoretical study, is 11 hours and 17 hours, respectively. In actuality, the time it takes to charge the batteries is approaching the theoretically calculated duration. In conjunction with today's technological use, IoT switches were placed as an extra component. For the conclusion, this device may be combined with current split type air conditioners and has a very large market potential. Furthermore, the energy output is predictable and consistent, allowing for continuous power generation via air conditioning

INTRODUCTION

Electricity is now an essential part of our daily life, and we expect to use it at all times, no matter where we are. There are two primary energy sources: conventional and non-conventional [1]. According to M. A. H. Jafri, H. Liu, A. Usman, and Q. R. Khan, [2], Conventional energy is produced from natural earth sources. In contrast, non-conversational energy is energy that can be regenerated.

Natural resources are natural gifts that are highly beneficial to people, and as wise men, we should make the most use of what we have. Solar and wind energy are non-conventional energy sources that can be a good option [3]. Wind power has surpassed all other renewable energy sources due to recent technology advancements [4].

Wind power is a renewable energy source that is both ecologically beneficial and efficient [5]. Windmills, made of wood, fabric, and stone and have been used to pump water or grind maize for hundreds of years, have been used to extract power from the wind [6]. Wind turbines are power devices used to create electricity using today's cutting-edge technology. Most modern wind power is produced as electricity by converting turbine blades to electrical current throughout the power generation process [7].

The increased interest in several studies on the design of efficient wind turbines has resulted in a significant increase in wind power generation [4]. The wind turbine design should be adequate for electric generation when split-type air conditioners are used as this study's wind energy source.

The wind is moving air that is caused by the earth's rotation and is followed by a variation in air pressure [8]. Wind power is generated by an amount of air that hovers over the earth's surface and generates kinetic energy. The kinetic energy received by the wind turbine blades can then be converted into mechanical or electrical power. The efficiency with which wind is converted to various types of energy is determined mainly by the rotor's interaction with wind flow [9].

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Wind power was one of the first kinds of energy discovered, and it was once utilised to propel ships and boats. The majority of wind turbines now generate power. Between 2000 and 2009, the global capacity of wind turbine installation increased at a 30 percent yearly rate, reaching 318 GW in 2013 [10]. When wind power projects under development become operational in the next several years, it is predicted to grow by 350 percent [11].

Temperature, humidity, hygiene, and quality are all controlled simultaneously in air conditioning to fulfill users' needs [12]. The air conditioning system consists of components and equipment configured to condition the air, transmit the air to the conditioned room, and control the internal environment parameters in the specific area within the specified limits [13].

Institutional buildings (welfare homes and hospitals), commercial (offices, malls, and shopping centers), residential, and manufacturing structures all employ air conditioning systems [14]. Air conditioning systems are designed to suit the comfort needs of people in institutional, commercial, and residential buildings. Air conditioning systems are installed in manufactured buildings to suit product processing or storage needs and keep personnel healthy and comfortable in enclosed spaces.

Many other types of air conditioners are extensively used, but the split type air conditioner is one of the most popular options for residential and commercial buildings. This type of air conditioner is well-known for its quiet operation and attractive design [15]. The condenser and evaporator units are the two primary components of a split air conditioner system. The condenser contains an integrated compressor, condenser, fan, and expansion valve or capillary tubes, whereas the evaporator comprises a cooling coil, blower, and air filter.

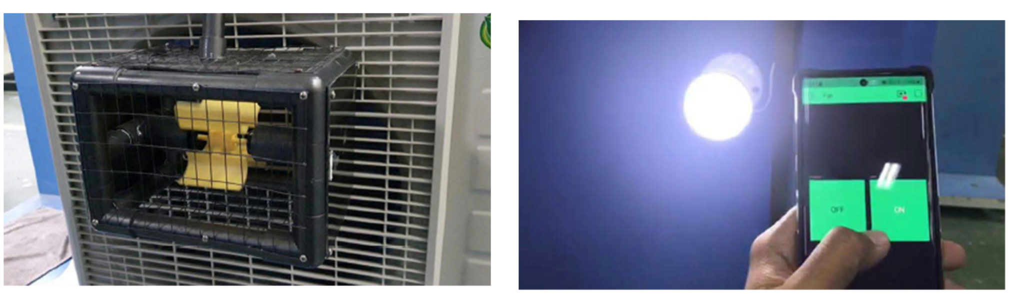
This research aims to design, develop, and test an energy recovery model using a split-type air conditioner's condenser unit. The product's operation will be evaluated. A study will be undertaken to determine how much electricity can be created depending on the wind speed supplied by the condenser unit and the time required to fully charge the batteries utilised in this study. It also aims to raise awareness about how to help adopt green technologies and the importance of alternative energy generation.

METHODOLOGY

The ADDIE design model is utilized as a guide to develop the product in this study. The ADDIE model is a guide for creating a practical design and is one of the most widely used models in instructional design [16]. The ADDIE model is also a design model that involves many phases. The acronym ADDIE stands for Analysis, Design, Development, Implementation, and Evaluation, representing the fundamental components in generating instructional designs.

The instructional design begins with the analysis step. The problems were stated, the cause of the problems was discovered, and remedies were determined at this phase. The analysis phase results are used in the design phase to choose the research strategy. There were three early sketches, one of which was used as the product's final design. The decision was made based on the product's reliability to develop a more cost-effective product.

The product was developed according to the final conceptual design and specifications during the development phase. During the implementation phase, the product was evaluated to identify any issues with its system and any necessary adjustments were made to improve it. Figure 1 shows the developed product being tested on the outdoor unit and the IoT apps for controlling household device.



(a) (b)

FIGURE 1. (a) The developed product was tested on the outdoor unit. (b) IoT apps use for controlling household device.

During the Evaluation Phase, the product's efficacy and functionality were assessed to see if they met the specified goals. Overall assessments will be conducted from the initial phase until the implementation phase. Formative and summative assessments are used in assessments. A formative review was completed prior to creating the finished product by assessing the earlier processes taken to enhance it. A summative evaluation was carried out after the finished product was ready.

RESULTS AND DISCUSSION

Every condenser unit of any split type of air conditioner uses different types of fan, so in this study, the average velocity of the fan's wind is shown in Figure 2 below.

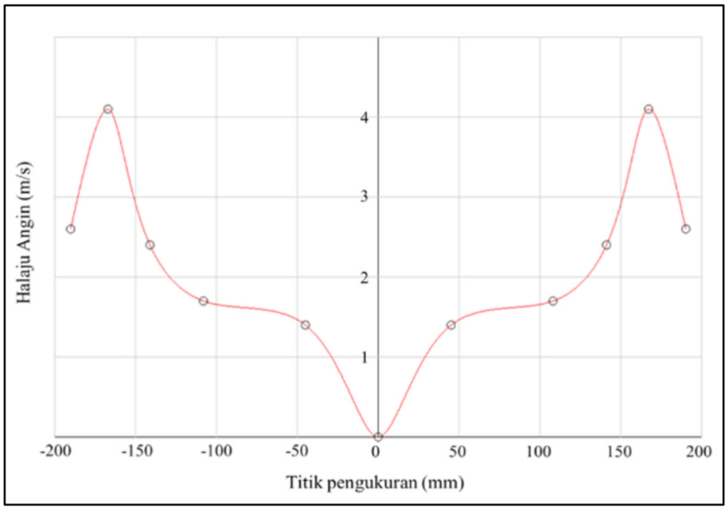


FIGURE 2. Average Wind Velocity From the Outlet of the Condenser Unit

The radius of the fan outlet is 200 mm and because there is a fan hub in the center of the outlet, the velocity measured was zero and it is assumed to cross the y-axis at the speed of 0 - 1 ms in the graph. Electricity produced by the wind turbine depends on the wind speed received from the outlet of the condenser unit. Every area of the outlet of the condenser unit produces different wind speeds, so positioning the wind turbine is important to ensure the best results are collected. Figure 3 shows the wind turbine's power based on the outlet's various positions.

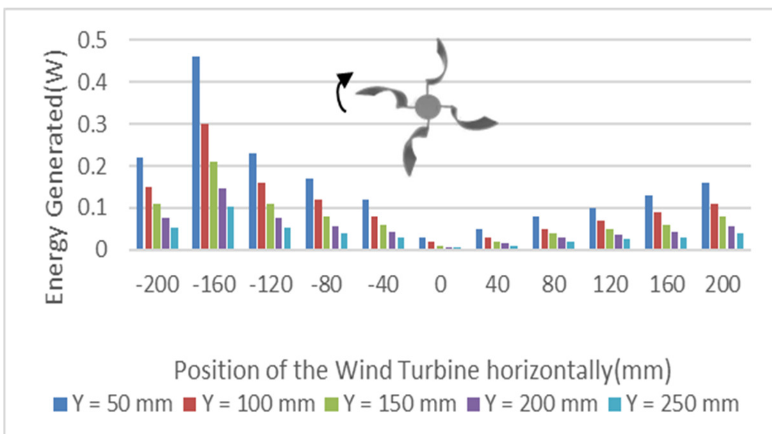


FIGURE 3. Power Generated by The Wind Turbine

As shown in Figure 3, the highest energy generated is 0.46 Watts, with the wind turbine's location on X= -160 mm and Y= 50 mm. Furthermore, the wind turbine has a calculated maximum power coefficient of 53%, which means it can convert 53% of the kinetic energy from the wind to spin the turbine and generate electricity. The electricity is then used to charge the power banks, allowing consumers to utilize it to power their low-voltage gadgets. The power bank has two sets of batteries: a supporting and a main battery with capacities of 1100 mAh and 20000 mAh, respectively. The supporting battery is charged by the wind turbine, while the supporting battery charges the main battery. The charging time for each battery is shown in Figure 4.

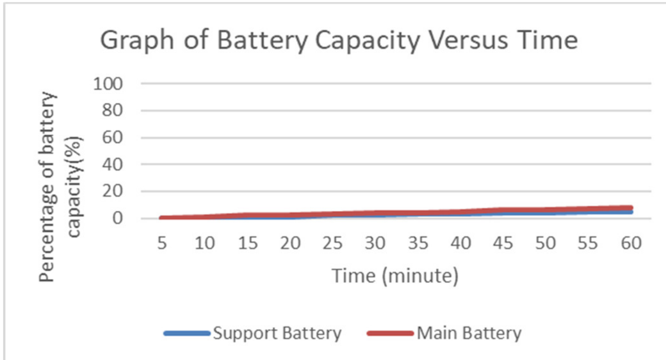


FIGURE 4. The Graph of Batteries Percentage Against Time Taken

The graph shows that the lines indicating both batteries to charge up increase over time in one hour. For the batteries to get 100% charged, the time required is around 11 hours for the supporting battery and approximately 17 hours for the main battery, as calculated.

The results demonstrate that the wind generated by the condenser unit could rotate the wind turbine, generating electricity. While charging the batteries that were utilised within the power banks may take a long time since the specification of a few components was downgraded due to low cost related, and the time given to complete the product is also limited, the developed system proved to be perfectly functional.

CONCLUSIONS

The product was developed effectively and met the previously stated objectives. It is a good idea to promote green technology. It can recover a portion of the electricity used on air conditioners by converting wind energy from the condenser unit's fan to electrical power via a wind turbine, which can then be utilised on small electrical appliances. According to the research, it can recover at least 1100 mAh of electricity after 11 hours of air conditioning turned on (1hp York). It still has a lot of space for improvement and requires a few enhancements for future research to be helpful.

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