Analysis of the Impact of Distance and Temperature in Determining Transfer Power Using Laser Applications

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Abstract: This article aimed to analyze the impact of distance and temperature in determining transfer power using laser applications. This study used instruments consisting of a power meter, photovoltaic, laser, and DC power supply. This research was using experimental method. The impact of distance and temperature in determining transfer power using laser applications was concluded based on the results of calculation analysis, measurements of photovoltaic output power, distance, temperature, and laser input power. The impact of distance and temperature in determining transfer power using laser applications showed that the probability value or p-value was lower than the error/alpha level (a) (2.207E-18 < 0.05). Likewise, the calculated F value is greater than the significance F (15290048>4.68386E-27). With the applicable provisions in testing the hypothesis, that the conclusion in this article rejected the null hypothesis (H0: The distance and temperature have not an impact in determining transfer power using laser applications), and accepted the alternative hypothesis (H1: The distance and temperature have an impact in determining transfer power using laser applications).

Keywords: Impact, Distance, Temperature, Power, Laser Applications

1. Introduction
The concept of wireless power transmission using the application of lasers with photovoltaic arrays is known as laser power beaming [1-4]. Laser power beaming can be an alternative for charging electric vehicles because it is able to transfer power to the receiver wirelessly, making it more convenient and safer [5], space applications [6]. The photovoltaic module circuit through the photovoltaic effect converts sunlight into electricity. Sunlight with a wavelength that carries photon energy excites electrons to move from the negative semiconductor to the holes in the positive semiconductor. In the photovoltaic effect that uses sunlight, not all solar wavelengths are absorbed by the photovoltaic module. This is because sunlight consists of various wavelengths or polychromatic. Sunlight with these various wavelengths or polychromatic is different from lasers that have one wavelength or monochromatic. So that the wavelength of the laser light on the laser power beaming will adjust to the wavelength of the p-n junction arrangement of photovoltaic cell materials or vice versa. [7].

The monochromatic laser beam passes through the atmosphere to the surface of the photovoltaic module in the concept of wireless power transmission, then the efficiency or output power of the photovoltaic module illuminated by the laser will be influenced by reducing factors the weakening of the light irradiation by way of the atmosphere. [8-11]. Imam Arif Rahardjo et al have conducted research showing that the temperature affects the irradiation of laser light through the atmosphere to the photovoltaic module [12]. Because distance impacts the temperature transfer of a substance. So, in this article will explain the analysis of the impact of distance and temperature in determining transfer power using laser applications.
2. Method
This study used instruments consisting of a power meter, photovoltaic, laser, and DC power supply. This research was using experimental method. The electric power generated by the power supply is used to activate the beam in laser applications. The light from the laser is captured by photovoltaics to be converted into electricity. The influence of the laser beam received by the photovoltaic from the laser in the form of changes in distance and changes in temperature is observed, measured using an energy meter, and analyzed for changes in the electrical power produced by photovoltaics.

Figure 1. Research Method

The research methods was shown in Figure 1. The impact of distance and temperature in determining transfer power using laser applications was concluded based on the results of calculation analysis, measurements of photovoltaic output power, distance, temperature, and laser input power.

To analyze the the impact of distance and temperature in determining transfer power using laser applications using the applicable provisions in testing the hypothesis. Where the null hypothesis (H0) will be rejected and the alternative hypothesis (H1) will be accepted, when the probability value (p-value) is lower than the error/alpha level (a). On the other hand, the null hypothesis (H0) will be accepted and the alternative hypothesis (H1) will be rejected , when the probability value (p-value) is greater than the error/alpha level (a). Likewise, the null hypothesis (H0) will be rejected and the alternative hypothesis (H1) will be accepted , when the calculated F value is greater than the significance F. On the other hand, the null hypothesis (H0) will be accepted and the alternative hypothesis (H1) will be rejected , when the calculated F value is lower than the significance F.

Null hypothesis (H0) : “The distance and temperature have not an impact in determining transfer power using laser applications”

Alternative hypothesis (H1) : “The distance and temperature have an impact in determining transfer power using laser applications”

3. Results
Table 1 ANOVA shows the results of the impact of distance and temperature in determining transfer power using laser applications.
Table 1. ANOVA of the Impact of Distance and Temperature in Determining Transfer Power using Laser Applications

|          | df | SS            | MS       | F            | Significance F |
|----------|----|---------------|----------|--------------|----------------|
| Regression | 2  | 1.1E-10       | 5.5E-11  | 15290048     | 4.68386E-27    |
| Residual  | 8  | 2.87769E-17   | 3.597E-18|              |                |
| Total     | 10 | 1.1E-10       |          |              |                |

|          | Coefficients | Standard Error | t Stat | P-value |
|----------|--------------|----------------|--------|---------|
| Intercept | 0.005216047  | 1.34641E-05    | 387,40397 | 2.207E-18 |
| Distance  | -0.000102308 | 2.6713E-07     | -382,99027 | 2.419E-18 |
| Temperature | 8.6313E-10 | 9.19447E-10   | 0.9387489 | 0.3753332 |

Based on Table 1 ANOVA of the impact of distance and temperature in determining transfer power using laser applications, it shows that the probability value (p-value) is lower than the error/alpha level (a) (2.207E-18<0.05). Based on rules in hypothesis testing as explained in the research method, it means the null hypothesis (H0: “The distance and temperature have not an impact in determining transfer power using laser applications”) will be rejected. And the alternative hypothesis (H1: “The distance and temperature have an impact in determining transfer power using laser applications”) will be accepted.

Likewise, the calculated F value is greater than the significance F (15290048 > 4.68386E-27). Based on rules in hypothesis testing as explained in the research method, it means the null hypothesis (H0: “The distance and temperature have not an impact in determining transfer power using laser applications”) will be rejected. And the alternative hypothesis (H1: “The distance and temperature have an impact in determining transfer power using laser applications”) will be accepted.

Figure 2. Impact of Distance and Temperature in Determining Transfer Power
Based on Figure 2 above, the lower of distance and temperature are, the higher energy that occurs is.

4. Conclusion
The results of the analysis shows that the probability value (p-value) is lower than the error/alpha level (a) \((2.207E-18<0.05)\). Likewise, the calculated F value is greater than the significance F \((15290048 > 4.68386E-27)\). Based on rules in hypothesis testing as explained in the research method, it means the null hypothesis (H0: “The distance and temperature have not an impact in determining transfer power using laser applications”) will be rejected. And the alternative hypothesis (H1: “The distance and temperature have an impact in determining transfer power using laser applications”) will be accepted.

Acknowledgements
The authors would like to thank International Conference Committee of ice-elinv 2021 which has accepted this article to be published.

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