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Cawangan Kedah  
Kampus Sungai Petani

Faculty of Administrative  
Science and Policy Studies

# i-SPIKE 2021

*Leading An Artificial Innovation In Knowledge, Education And Design*

## **i-SPIKE 2021 INTERNATIONAL EXHIBITION & SYMPOSIUM E-PROCEEDINGS**

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## POWER GENERATION USING THERMOELECTRIC POWER GENERATOR WITH PARABOLIC SOLAR CONCENTRATOR

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### ABSTRACT

Solar Thermoelectric Generator (STEG), a hybridization system of a thermoelectric generator (TEG) with a heat exchanger have been thoroughly explored because of its ability to produce both electricity and heat simultaneously. In this project, a STEG system consists of parabolic solar dish collector and a single TEG was constructed to produce both heat and electricity simultaneously. An absorber plate placed on the focal point of the dish was used to facilitate the heat transfer of the reflected solar radiation to the TEG through the plate. The absorber plate thickness was 1 mm and made up from copper to ensure high heat transfer rate and was well insulated to ensure minimal heat loss. To evaluate the performance of the STEG, Water-Cooled Cooling Method with Water Heat Sink and Air-Cooled Cooling Method (Forced-Convection) with Finned Heat Sink were introduced to cool down the generators. Results showed that Water-Cooled Cooling Method with Water Heat Sink was more effective to cool down the generator and allow a higher electricity being generated than air-cooled cooling method.

**Keywords:** Thermoelectric power generator, Parabolic Solar Dish Collector, Solar Energy, Solar Thermoelectric Generator.

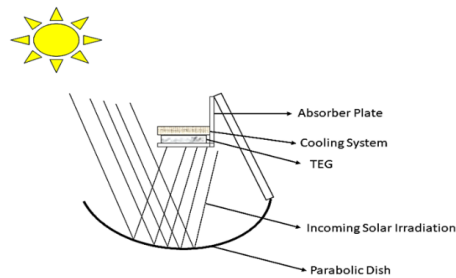
### BACKGROUND

It is vital for our society to realize the consequences of using fossil fuels as the main energy resource, especially when we are too dependent on it. We have been utilizing fossil fuels for almost two hundred years (Gomesh et al., 2013). Burning of fossil fuels will emit pollutants to the atmosphere, which will cause greenhouse effects and global warming. To ensure the sustainability of our future, using renewable energy as an alternative to fossil fuels is a great start. Renewable energy is a clean energy source because it does not harm the environment. Also, they are finite and does not deplete. Solar energy, as one of the many renewable energies available, is widely used for thermal and electrical power generation. To harness the solar energy, a solar collector is needed. In this research, a parabolic solar dish concentrator is coupled with thermoelectric generator (TEG) to generate power. TEG is a solid state device

that converts thermal energy to electrical energy directly (Ismail & Ahmed, 2009). TEG is compact, robust, have no moving parts, relatively simple, and environmentally friendly (Eswaramoorthy et al., 2013). This hybridization system is called Solar Thermoelectric Generator (STEG). STEG can produce both electricity and heat. To further enhance the performance of STEG, a water-cooled cooling method with water heat sink and air-cooled (forced convection) with finned heat sink are introduced.

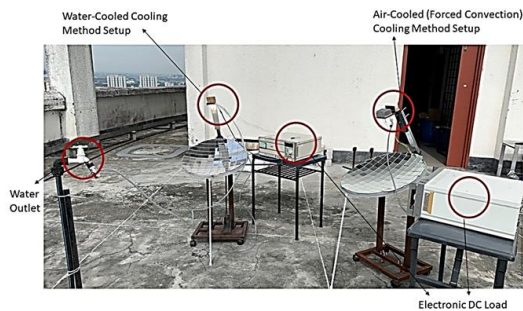
## METHODOLOGY

The conceptual design of the parabolic solar dish concentrator is illustrated in Figure 1. A recycled satellite dish is used as the collector. The dish is covered by small segment of mirrors. One thermoelectric (TE) module is placed at the focal point of the dish. The cooling system used in this research were water-cooled with water heat sink and air-cooled (forced convection) with finned heat sink. For the air-cooled cooling method, a USB powered fan is placed on top of the finned heat sink.



**Figure 1: Schematic Diagram of the setup**

For efficient experimental data collection period, both water-cooled cooling method and air-cooled (forced convection) cooling method are conducted concurrently. The experiment is conducted for two days (21/11/2019 and 22/11/2019). Both setups are placed side by side as shown in Figure 2. To ensure optimum concentration, the axis of the reflector is set to be parallel with the incoming radiation. This is to focus the solar ray's incidents to the concentrated area. To achieve this, the parabolic concentrator is manually adjusted 5 minutes before each intervals of 30 minutes so that maximum solar radiation was reflected onto the TEG. The adjustments are based on two-axis tracking mechanism. At each intervals, the parameters (ambient temperature  $T_{amb}$ , hot side temperature  $T_{hot}$ , cold side temperature  $T_{cold}$ , water in temperature  $T_{water,in}$  and water out temperature  $T_{water,out}$  for water-cooled cooling method setup) are taken and tabulated. The experiment is conducted for 4 hours, from 11.00 a.m. until 3.00 p.m.

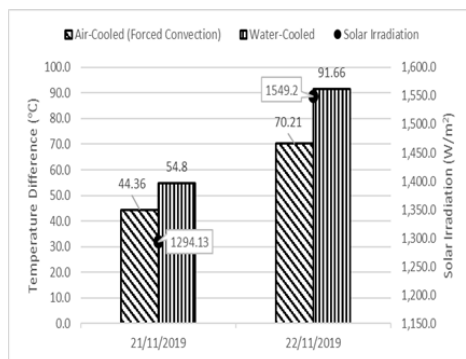


**Figure 2: STEG setup for both cooling methods**

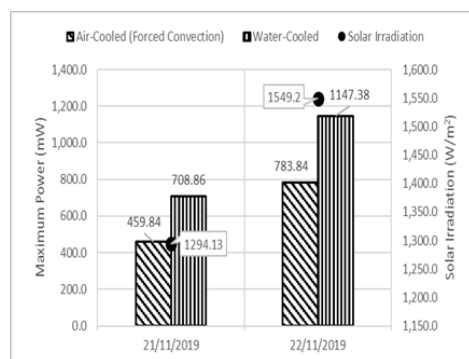
## RESULTS

Figure 3 shows the comparison of TEG temperature difference value and the solar irradiation value for both cooling methods for both experimental days. As expected, water-cooled cooling method are able to cool the TEG more efficiently. A larger temperature gradient is established; hence a higher power output is generated.

Figure 4 shows the comparison of the maximum power generated and the solar irradiation value for both cooling methods for both experimental days. The highest power generated among the introduced cooling methods is consistent with water-cooled cooling method. It is no doubt that water-cooled cooling method is able to enhance the performance of the TEG for maximum power generation possible.



**Figure 3: Comparison data of TEG Temperature Difference for both cooling methods.**



**Figure 4: Comparison data of Maximum Power Generated by the TEG for both cooling methods.**

## CONCLUSION

The highest power generated for water-cooled cooling method is 1148 mW whereas the highest power generated for air-cooled cooling method is 784 mW for solar irradiation of 1550 W/m<sup>2</sup> with TEG temperature difference of 92°C and 70°C. All results showed TEG power output increases as TEG temperature difference increases. Water-cooled cooling method is indeed the most efficient cooling method to cool down the generator for high power generation.

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