MINISTRY OF INDUSTRY AND TRADE
ELECTRIC POWER UNIVERSITY

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INFORMATION ON NEW CONCLUSIONS OF DOCTORAL DISSERTATION

(Information will be posted on the Website)

Name of dissertation: Research on passive cooling to improve the conversion efficiency of photovoltaic panels using heat sinks.

Major: Energy Engineering Code No: Pilot

Name of PhD. Student: **Dang Van Binh**

Advisors: **1. Dr. Pham Quang Vu**

2. Dr. Pham Manh Hai

Training Institution: **Electric Power University**

Summary of new contributions of the Dissertation

1. Mathematical models were developed to determine the operating temperature of photovoltaic panels, both with and without cooling, based on the heat transfer equation and energy balance methods under steady-state and unsteady-state conditions. The accuracy of the mathematical models was evaluated compared with previous papers. The results showed that the constructed mathematical model was accurate.

2. Three heat sinks with aluminum fins and aluminum base, and bases with an added copper layer of 1mm and 2mm thickness were fabricated. The heat transfer efficiency of heat sinks was evaluated in the downward-facing fin, and their heat transfer coefficients were as follows:

+ Aluminum heat sink:

$h = 1.6643(T_{base} - T_{amb})^{0.1832}$

+ Aluminum heat sink with base added 1mm copper layer:

$h = 1.5922(T_{base} - T_{amb})^{0.2032}$

+ Aluminum heat sink with base added 2mm copper layer:

$h = 1.5557(T_{base} - T_{amb})^{0.2279}$

3. The influence of factors such as radiation intensity, ambient temperature, wind speed, and tilt angle on the cooling and conversion efficiency in the laboratory was evaluated when attaching heat sinks to the back of a 50W monocrystalline photovoltaic panel. Aluminum heat sinks, aluminum heat sinks with an added copper layer of 1mm and 2mm thickness resulted in the maximum reductions in operating temperature of the photovoltaic panel by 14.3°C, 14.7°C, and 15.6°C, respectively, compared to ones without cooling. Thereby, they help increase in conversion efficiency of 1.03%, 1.06%, and 1.12%, respectively, corresponding to increase in output power of 6.84%, 7.04%, and 7.43% compared to ones without cooling.

4. Outdoor experiments to evaluate the cooling efficiency of photovoltaic panels using heat sinks were conducted on July 27, 2025 and September 13, 2025. Specifically, on July 27, 2025, the aluminum heat sinks and the aluminum heat sinks with an added copper layer 2mm thickness reduced the operating temperature of the photovoltaic panel by 6.0°C and 7.1°C respectively, thereby increasing the average conversion efficiency of the photovoltaic panel by 0.38% and 0.45% respectively compared to ones without cooling; On September 13, 2025, the aluminum heat sinks and the aluminum heat sinks with an added copper layer 2mm thickness reduced the operating temperature of the photovoltaic panel by 5.4°C and 6.3°C respectively, thereby increasing the average conversion efficiency of the photovoltaic panel by 0.38% and 0.43% respectively compared to ones without cooling.

Ha Noi, 15th April 2026

Advisors **PhD. Student**

Advisor 1 **Advisor 2**

Dr. Pham Quang Vu **Dr. Pham Manh Hai** **Dang Van Binh**