



**IMPROVEMENT OF THE PHOTOVOLTAIC
OUTPUT PERFORMANCE USING HYBRID
ACTIVE AND PASSIVE COOLING SYSTEM**

by

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DECLARATION OF THESIS

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LIST OF ABBREVIATIONS

1-D	One-dimensional
2-D	Two-dimensional
3-D	Three-dimensional
AC	Alternating Current
ADC	Analog-to-Digital Converter
Avg.	Average
BIPV	Building-integrated Photovoltaic
CAD	Computer-Aided Design
CATIA	Computer Aided Three-dimensional Interactive Application
CERE	Centre of Excellence for Renewable Energy
CFD	Computational Fluid Dynamic
CFM	Cubic Feet Meter
DC	Direct Current
EVA	Ethylene Vinyl Acetate
FiT	Feed-in Tariff
HCPV	High-Concentration Photovoltaic
IEC	International Electrotechnical Commission
E	East
N	North
NIL	Not In List
ISS	Integrated Sensor Suite
LCD	Liquid Crystal Display
MAT	Maximum Allowable Temperature
Max	Maximum

Min	Minimum
OpenFOAM	Open Source Field Operation and Manipulation
PCM	Phase Change Material
PN	P-type and N-type
PSH	Peak Sun Hour
PV	Photovoltaic
PV/T	Hybrid Photovoltaic/Thermal
PVC	Polyvinyl Chloride
RM	Ringgit Malaysia
SEC	Solar Energy Centre
STC	Standard Test Condition
UniMAP	Universiti Malaysia Perlis

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LIST OF SYMBOLS

W	Watt
kWh/m ²	Kilowatt hour per metre square
kWh	Kilowatt hour
MW	Megawatt
GW	Gigawatt
W/m ²	Watt per metre square
<i>I-V</i>	Current and voltage
kW	Kilowatt
<i>A</i>	Surface area of the PV panel
m ²	Meter square
mm/hr	Millimeters per hour
m/s	Metre per second
<i>Q</i>	Heat transfer rate
<i>K</i>	Thermal conductivity
W/(m · °C)	Watts per meter-degree Celsius
°C /m	Degree Celsius per meter
<i>T_H</i>	Temperature of hot surface
<i>T_C</i>	Temperature of the cold surface
ΔT	Difference between hot and cold temperature
Δx	Thickness of the panel
<i>h</i>	Coefficient of convective heat transfer
<i>T_S</i>	Operating temperature of PV panel surface
<i>T_f</i>	Temperature of fluid
<i>v</i>	Wind speed
μm	Micrometre

P	PV panel produced as heat
σ	Stefan-Boltzmann
ε	Emissivity
T_{PV}	Operating temperature of PV panel
T_{amb}	Ambient temperature
J/kg °C	Joule/Kilogram-degree Celsius
kg/m ³	Kilogram per cubic meter
m ² /s	Metre squared per second
cm	Centimetre
m	Metre
°C	Degree Celsius
% / °C	Percentage per degree Celsius
%	Percentage
Q_{conv}	Amount of convection heat transfer
\dot{m}	Mass flow rate
C_p	Specific heat capacity
T_{film}	Film temperature
ρ	Density
$P_{max_{corrected}}$	Corrected output power of the PV panels according to the temperature coefficient
$P_{max_{stc}}$	Maximum output power under STC
γ	Maximum output power temperature coefficient
L/h	Liter/hour
kg/l	Kilogram per liter
V	Voltage
A	Current
kJ/kg	Kilojoule per kilogram

$\text{kJ/kg } ^\circ\text{C}$	Kilojoule per kilogram degree Celsius
kW	Kilowatt
eV	Electron volts
η	Refractive index

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