

**GLOBAL, DIRECT AND DIFFUSE SOLAR  
INSOLATION ANALYSIS ON HORIZONTAL AND  
TILTED SURFACES AT COLOMBO, SRI LANKA**

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Department of Mechanical Engineering

University of Moratuwa

Sri Lanka

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Thesis submitted in partial fulfillment of the requirements for the degree  
Master of Engineering

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## ABSTRACT

An analysis of global, direct and diffuse solar radiation on horizontal and tilted surfaces at Colombo was carried out to assess the solar resource potential on horizontal and tilted surfaces. The calculated monthly average global horizontal solar resource potential varied between 4.00 to 5.95 kWh/m<sup>2</sup>/day while 5.00 kWh/m<sup>2</sup>/day was the calculated annual average global horizontal solar resource potential at Colombo. Estimated annual average diffuse solar radiation component on horizontal surface was 1.82 kWh/m<sup>2</sup>/day and the direct solar radiation component was 3.18 kWh/m<sup>2</sup>/day which was about 63.6% of the global horizontal insolation at Colombo. Solar resource assessment was then carried out for tilt angles 15°, 17.5°, 22.5°, 30°, 40° and 6.9° for the tilted surfaces in due south orientation. The derived maximum solar resource potential was 1830 kWh/m<sup>2</sup> per annum for the surface tilt angle of 6.9° which is equal to the local latitude. The solar resource potential was decreased with increased surface tilt angle. The percentage decrements compared to the global horizontal solar radiation were 0.7%, 1.4%, 3.0%, 6.8% and 14.3% for surface tilt angles of 15°, 17.5°, 22.5°, 30°, and 40° respectively. According to the results of the analysis, it is required to tilt the surface maximum of 30° towards the south and maximum of 25° towards the North during a year to maximize the solar resource potential on the tilted surface free to rotate about its East-West axis, placed at zero surface azimuth angle. 1918 kWh/m<sup>2</sup> per annum was the estimated maximum possible solar resource potential on tilted surface which is 5.1% greater than that of horizontal surface. With the availability of Solar Radiation data, it may possible to assess the Solar Resource Potential of any other location of the country in future by using the same procedure.

**Key Words:** Global Horizontal Solar Radiation, Direct & Diffuse Solar Radiation, Solar Radiation Model, Colombo



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## LIST OF ABBREVIATIONS

ASHRAE	American Society of Heating Refrigerating and Air conditioning Engineers
CEB	Ceylon Electricity Board
CSR	Climatological Solar Radiation
DNI	Direct Normal Irradiation
ESD	Energy Services Delivery
GHI	Global Horizontal Irradiation
HDKR	Hay-Davis-Klucher-Reindl
LECO	Lanka Electricity Company
MBE	Mean Bias Error
NASA	National Aeronautics and Space Administration
NREL	National Renewable Energy Laboratory
PV	Photo-Voltaic
RERED	Renewable Energy for Rural Economic Development
RMSE	Root Mean Square Error
WMO	World Metrological Organization
SLSEA	Sri Lanka Sustainable Energy Authority
SSE	Surface metrology and Solar Energy
SWERA	Solar and Wind Energy Resource Assessment



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