Solar Radiation Data Quality Analysis and Gap Filling Approaches

A Thesis submitted by

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Conclusions and Future Work

Solar radiation resource assessment is a crucial part in the planning and implementation of any solar power installation. A good quality radiation database is required for this task. Radiation data can be downloaded from several international agencies such as NREL, NASA, BSRN, IMD, etc. But before deriving any conclusions from these databases, proper data quality analysis is required. Detailed data quality control guidelines and other visual approaches for understanding radiation data are discussed in this thesis. By using this information site-specific radiation databases and their detailed quality reports can be generated.

In this research work to correctly understand the radiation pattern, all three components of solar radiation are considered. Different types of clouds are identified using radiation and transmittance plots. Using "k_t-k_n" plot, standard limits for transmittance values are set, which help in identifying location-specific climatic conditions. Next, by using quality control guidelines, various types of measurement errors in radiation components are identified. Some unique days, having different radiation measurement pattern are also studied and specific results related to mixed climatic and instrument based errors are analyzed. Using these results, one can determine the errors in individual radiation components.

Errors identified during the data evaluation process need some correction. Hence various gap filling approaches are identified for filling them. Some random days are selected (having various climate conditions) and by applying all gap filling approaches, reliable models for each cloud condition type are discussed. "RMSE" calculation for each condition (climate conditions, gap size and different approaches used for gap filling) is studied and various conclusions related to gap filling are drawn, thus leading to the creation of an error-free radiation database.

Based on the work done in this thesis, following conclusions are arrived at:

- Cloud classification is done, using only radiation values from ground stations. Various cloud condition days are identified and their transmittance ratio and scatter plots are studied.
- Basic solar radiation data quality control techniques, allow for a better understanding of radiation databases, even though the satellite data is not used.
- Combining visual plots, quality control results and environmental conditions, the measurement errors in individual radiation components can be determined.
- Gap filling methods in radiation databases are suggested based on climatic condition.
- The database selected for analysis (IMD Jodhpur, 2015, 10-minutes interval) is thoroughly studied and various results are discussed: climate conditions, quality control results, individual radiation components error results and coherence error factor.
- Comparison of the raw database with corrected radiation database (actually measured radiation components and RMSE) indicates, that it is essential to go through the process

outlined in this thesis before solar resource assessment for solar thermal power plants is carried out.

- Comparison of two radiation databases (corrected IMD radiation database with SRRA station) shows good correlation between them.

Further work is required in solar resource assessment for solar power plants. Scope for extending this work is discussed below:

- This thesis considered only hot and dry zone and other climatic zones can also be studied using this approach.
- Use of detailed meteorological radiation databases (location specific radiation equations) and satellite data can also help improve the gap-filling algorithms accuracy.
- Highly accurate solar maps can be made using the procedure outlined in this thesis.