

Research Publications

Refereed Journals

- [1] **Brahma, H.**, and Sarmah, N. Performance Analysis of Spectrum-Dependent Integrated Thermal–Electrical Model of a PV Module. *IEEE Journal of Photovoltaics*, 13(3), 467-475, 2023.
- [2] **Brahma, H.**, Pant, S., Micheli, L., Smestad, G. P., and Sarmah, N. Effect of Environmental Factors on Photovoltaic Soiling: Experimental and Statistical Analysis. *Energies*, 16(1), 45, 2022.
- [3] Smestad, G. P., Germer, T. A., Alrashidi, H., Fernández, E. F., Dey, S., **Brahma, H.**, Sarmah N., Ghosh, A., Sellami, N., Ibrahim A. I. Hassan, I. A. I., Desouky, M., Kasry, A., Pesala, B., Sundaram, S., Almonacid, F., Reddy, K. S., Mallick, T. K., and Micheli, L. Modelling photovoltaic soiling losses through optical characterization. *Scientific reports*, 10(1), 1-13, 2020.

Other Publications during the Ph.D. period (Refereed Journals)

- [1] Saharia, B. J., **Brahma, H.**, and Sarmah, N. A review of algorithms for control and optimization for energy management of hybrid renewable energy systems. *Journal of Renewable and Sustainable Energy*, 10(5), 053502, 2018.

Book Chapters

- [1] **Brahma, H.**, and Sarmah, N. Spectrum-Based 3D Thermal Modeling of the PV Module: Simulation and Experimental Study. In *Advances in Thermofluids and Renewable Energy*, pages 493-502, 2022. Springer, Singapore. ISBN: 978-981-16-3497-0.
- [2] Baig, H., **Brahma, H.**, Mallick, T. K., and Sarmah, N. Technological Development for Capturing Regeneration, Standardization, and Storage of Solar Energy: Current Status and Future Direction. *Sustainable Biofuels Development in India*, pages 391-432, 2017. ISBN: 978-3-319-50219-9.

Conferences

- [1] **Brahma, H.**, Baruah, L., and Sarmah, N. Electrical and thermal modelling to evaluate photovoltaic module performance in varying outdoor condition. In *2018 2nd international conference on power, energy and environment: towards smart technology (ICEPE)*, pages 1-6, June 2018. IEEE. ISBN: 978-1-5386-4770-7.
- [2] **Brahma, H.**, and Sarmah, N. Development of Spectrum-dependent model and estimation of the energy-yield of the PV module with the real spectrum. In *National Conference on Renewable Energy Technology Utilization for Rural Development and Trade Show (NCRETURD 2017)*, 2017. Department of Energy Engineering, NEHU, Shillong, Meghalaya.

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CHAPTER 1

INTRODUCTION

This chapter introduces the topics related to the present work. Section 1.1-1.8 gives an overview of the topics, theories, and definitions relevant to the present work. Section 1.9 provides the motivation of the work. Section 1.10 presents the research objectives of the work and their significance, and Section 1.11 deals with the structure of the thesis.

1.1 Solar energy

Solar energy is generated by nuclear fusion in the sun. This energy source is known for its everlasting, renewable, clean, and equitable availability. About 1.8×10^{17} MW of solar energy gets intercepted by the earth, which is significantly more than the present total amount of power use [1].

The renewable energy sources came to focus in 1970s due to oil crises. During that period the energy insecurity increased significantly mainly the fossil fuel leading to the various governments including the developed countries to initiate programs to search of renewable energy sources. Other factors that supported its importance and growth are concerns related to emission of greenhouse and global warming, uneven distribution of fossil fuel and oil fields, greater financial risk and uncertainty [1]. The global oil and natural gas hike in late 2020 due to the relaxation of COVID-19 restrictions and the Russia-Ukraine war has raised concerns about obtaining net zero emissions through enhanced technological support and progress. Thus, this has declined the cost of photovoltaic, wind energy storage systems, and other renewable energy. Total amount of electricity generated from fossil fuels has dropped from 65% in 2018-2021, the reason being the growth in the contribution of photovoltaic and wind in electricity production. The total contribution of renewable in electricity generation has increased from 500 TWh in 2020 to 8000 TWh in 2021, especially due to generation from solar photovoltaic and wind as reported by International Energy Agency (IEA) in World Energy Outlook, 2022 [2]. Figure 1.1 depicts the share of

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