Cost-Efficient and Simple Hands-On Experiments for Education in Renewable Energy Systems *(Poster)*

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Active learning and practice-oriented teaching stimulates the student abilities and improves their performance significantly in comparison to traditional lectures. However, most practical lessons in renewable energy are restricted to demonstration sessions run by an instructor handling expensive equipment or limited field trips where students observe the plants at a distance. The unidirectional lecturing and lack of hands-on exposure further alienates the students and makes renewable technology seem mysterious. The writers propose a hands-on education framework suitable for university and high school students which explains a vast majority of photovoltaic (PV) and wind energy concepts through simple experiments using low-cost equipment for classrooms of up to 30 students. Proposed experiments cover PV and wind power equipment, installation, functionality, controllers, dependency on physical factors, and storage sizing along with basics of electrical engineering required to understand a decentralized grid structure. Students are divided into groups of five to encourage collective learning and team-work. The teachers introduce the core principles through a short lecture like presentation at the beginning of the lesson. The cohesion of the sub-tasks ensures that the students remain motivated throughout the course. Students are expected to analyze the results using computer tools (e.g. free spreadsheet processors) which further the active learning process. These individual sessions are followed by a student project addressing a real world scenario, such as a proposal for a new PV and storage installation in a neighbourhood building, which will require the students to bring together aspects from the experiment modules. This methodology has been successfully implemented in Rupert Mayer High School, Makonde, Zimbabwe in a workshop organized by TU Munich for 22 high school students. A university-level version of the same course is created by deepening the curriculum and by using advanced data visualization, sensors for feedback measurement and Raspberry-Pi for data logging and analysis.

Keywords: Renewable energy education; Active learning; Hands-on education; Low-cost equipment; Group work

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