

**PROMOTION OF HYBRID RENEWABLE ENERGY SYSTEMS TOWARDS  
ELECTRICITY ACCESS IN UGANDA (PHRE)**

**WORKSHOP REPORT**

**MAKER MOVEMENT INSPIRED PRACTICAL COURSE: Applications towards Hybrid  
Energy systems**





session by Dr. Rafat Al Afif, who provided an overview of Hybrid Renewable Energy Systems. His session set the stage for the Maker Movement's practical course and focused on two key

1. Dr. Rafat Al Afif discussed strategies to maximize biogas production and the challenges associated with integrating it into hybrid energy systems. Solutions to improve efficiency and feasibility were also explored. This session took place on the first day of the workshop (22nd February 2025).
- This session focused on the proper configuration and sizing of hybrid system components, including PV arrays, battery banks, charge controllers, and inverters. The importance of ensuring the optimal performance of key system components, particularly charge controllers, was emphasized.
  - Various types of charge controllers were discussed, including:
    - a. Hybrid charge controllers
    - b. Battery Management Systems (BMS)
    - c. Standard charge controllers
    - d. Pulse Width Modulation (PWM) controllers
    - e. Maximum Power Point Tracking (MPPT) controllers
  - The discussion also highlighted the necessity of charge controllers in preventing battery overcharging and undercharging, as well as the associated risks.





This course was conducted over a three-day period. The course was facilitated by Florian and focused on hands-on learning experiences aimed at enhancing participants' understanding of The tasks were designed to progressively build the participants' knowledge and skill set,

For this task we used an external 12VDC power supply and an IRLZ44 -n-channel MOSFET for simple low-side switching. MOSFETs (Metal-Oxide-Semiconductor Field-Effect Transistors) are critical components in power electronics and energy systems. This task introduced participants to the principles of current switching using MOSFETs and was divided into two subtasks:

- **Subtask A: Switching ON and OFF** Participants learned the fundamental principles of controlling electrical current flow using MOSFETs. Practical exercises involved turning circuits on and off by controlling the MOSFET gate voltage.
- **Subtask B: Pulse Width Modulation (PWM)** Pulse Width Modulation was introduced as a technique for controlling power delivery. Participants explored how varying the duty cycle of a PWM signal can regulate power output in hybrid energy systems.

This task focused on equipping participants with the knowledge and skills required to measure voltage accurately in an electrical circuit. Participants worked with sensors and microcontrollers to measure voltage levels, a fundamental aspect of monitoring and managing energy systems. The output was observed on the CRO. Building on this task, participants learned techniques for measuring electrical current. They were introduced to different types of current sensors and their applications in hybrid energy systems.



This was the final task which brought together all the concepts covered in the workshop, guiding participants through the process of designing and implementing a basic battery charge controller. Participants applied their knowledge of MOSFET switching, voltage and current measurement, and data display to develop a functional system capable of regulating battery charging in a hybrid energy setup. Two groups set up the circuit on the breadboard while the other two groups built the prototype on protoboards.



The workshop provided a valuable hands-on learning experience, enabling participants to develop practical skills applicable to hybrid energy systems. Through structured tasks, participants gained insights into electronic switching, power regulation, and system monitoring. By the end of the three-day course, attendees had acquired the foundational knowledge necessary to apply these concepts to real-world energy solution



