KNUST-TUM PV Knowledge Hub

ProPENS WiSe'24 Ghana

The KNUST-TUM PV Education hub project is one of the first steps from the TUM ENS chair as a long-term vision for strategic and sustainable partnership with KNUST, Ghana. In the shorter-term, we are attempting to cultivate an entrepreneurial mindset among students and enhancing renewable energy skills through block-course format, short education camps.

Overall vision

We focus on knowledge transfer, particularly through "Teach the Teachers" strategy, emphasizing local ownership and teaching capacity building. The daily operation and management of the PV Knowledge hub will remain the sole responsibility of KNUST collaborators, with TUM providing advisory support.

All course content will be open-source, fostering wider accessibility. They should also have interactive lectures with focus on "Active Learning" and "Learning by doing" paradigms, multimedia teaching material for renewable energy systems, experiments with Lego components, 3D printed schematics and circuit layouts for power electronics components and emphasis on reproducability of teaching material for a variety of countries. Furthermore, video explainers to the teachers, IT tools to create a local encyclopedia of lecture resources for smartphones and computers, group activities with a competitive edge, should also be part of the course development cycle.

ProPENS 2024 Ghana - Overview

Two ProPENS groups are being conceptualised to assist in design and development of the KNUST-TUM PV Education hub. The following are the common expectation from both groups,

Expectations

- The program will be developed for the KNUST-TUM PV Education Hub in Kumasi. A periodic sync and progress update with the end-user is KNUST is to be expected.
- The "DBU Schüler Labor" in ZEI will be used as a local proxy for the end-user. Continuous feedback and surveys should be conducted with the attending teachers and students.
- All major design and development decisions should be made with the end-user in loop.
- Expert sessions with school teachers and renewable energy educators will be organised.
- While being focused on a specific end-user, a business plan to sustain the Renewable Energy Education Program for other countries, customers brackets, through a student-led non-profit format should be explored.
- Deliverables include - Developed material in hard-copy and software format, project report, presentations, business plan (if applicable).
- An outlook for sustainable practices, inclusive classrooms, empathy for other cultures and a desire to democratise renewable energy education should be the guiding principles of the developed products.

Support for the groups

Each group will be supported by the TUM PhD students leading the initiative, whose broader research interests is aligned for education technologies for dissemination of Renewable energy know-how.

The course content and collection of experiments will be provided to the ProPENS cohort. The entire PV-Education hub program will be built by student volunteers, PhD candidates and post-docs at the ENS chair. The tutors for this project are also part of the "Student laboratory for renewable energy systems" project funded by the German Environment Scholarship body. They have also led renewable energy camps in Zimbabwe, Nepal and India.

If needed, professional tools and freelancer services can be availed by the groups for a higher quality finished product.

ProPENS 2024 Ghana - Topics

Group #1 - Pedagogical development of a Renewable Energy Education program

Student and Teacher Handouts

- Create a series of handout for the students based on the lesson plan provided for the experiment series
- Create an equivalent handout for the teacher with time-planning, checkpoints, clear learning outcomes and other best practices.
- Provide figures, tables, photos in an eye-catching fashion for the students.

Developing the experiment kit

- Research all the available resources to produce experiment kits based on the provided lesson plan.
- Analyse the cost efficacy of sourcing components locally without losing significant quality in the learning experience.
- Create CAD, PCB schematics and code repositories wherever required.

Group #2 - Education technology for a Renewable Energy Education program

IT infrastructure

- Create a repository for tutorials, slides, video explainers, experiment plans, which can be hosted both offline and online
- Create an offline version of the repository with an easy update mechanism to host the program at locations without internet connectivity with no change in the learning experience
- Integrate modern classroom features such as - tracking performance, pop-quizzes, homework portal etc.
- Create demo for a professional UI/UX front-end for the IT infrastructure tailored for both mobile and PC users.

Video resources

- Research all available resources - animated format, AI generated, speech-to-video, to make explainer videos as accompaniment for the student and teacher handouts.
- Produce the videos for the provided lesson plan.

References

The course content for the Renewable Energy Education program will be similar to the rubric provided below.

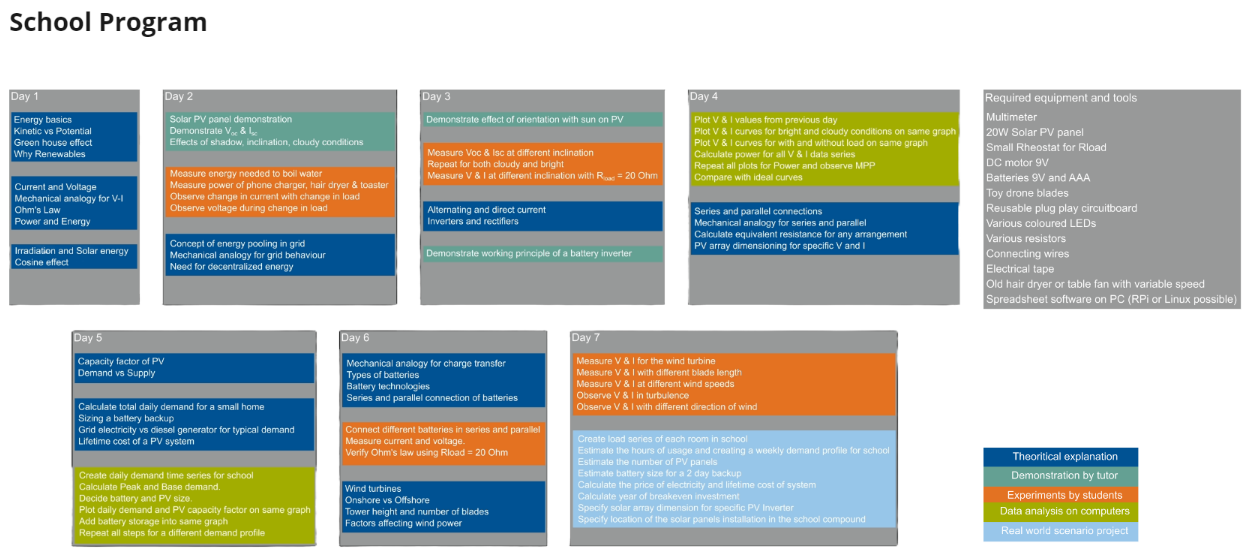

Figure 1: 7-day renewable energy camp in St. Rupert Mayer, Zimababwe 2017.

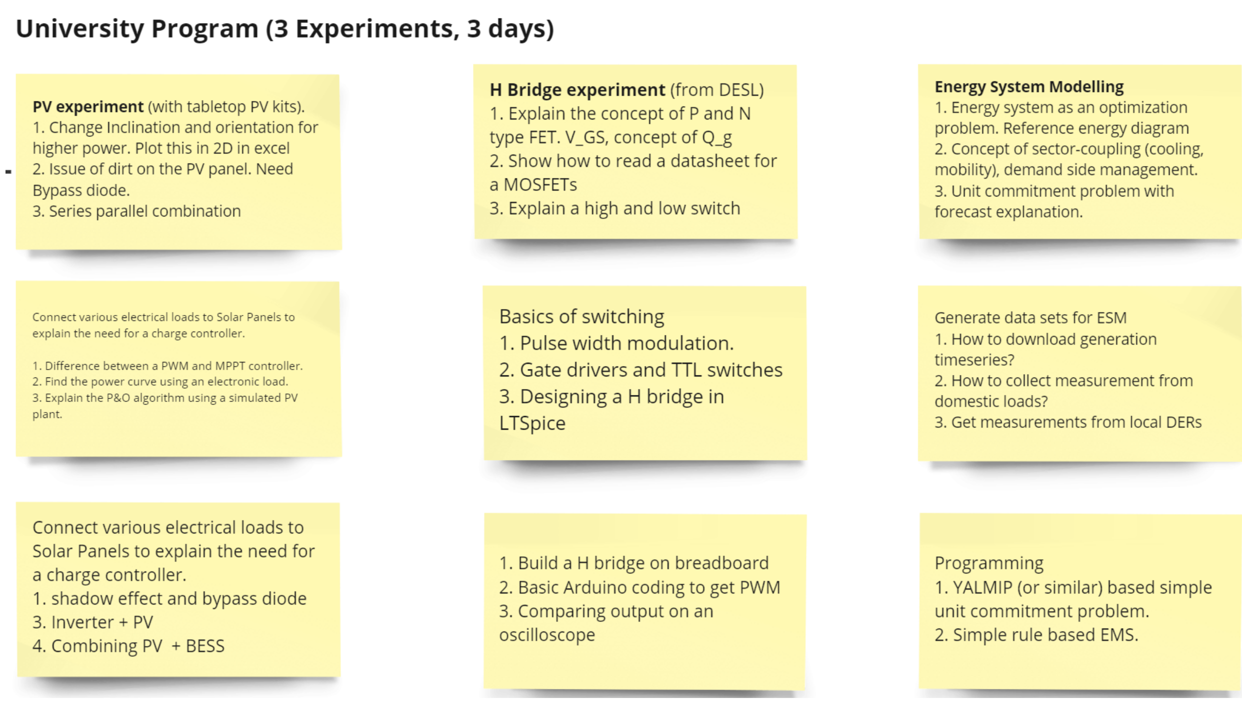

Figure 2: Three experiment sessions with theoretical lessons for university students.

A typical lesson-plan for a single topic could like the following,

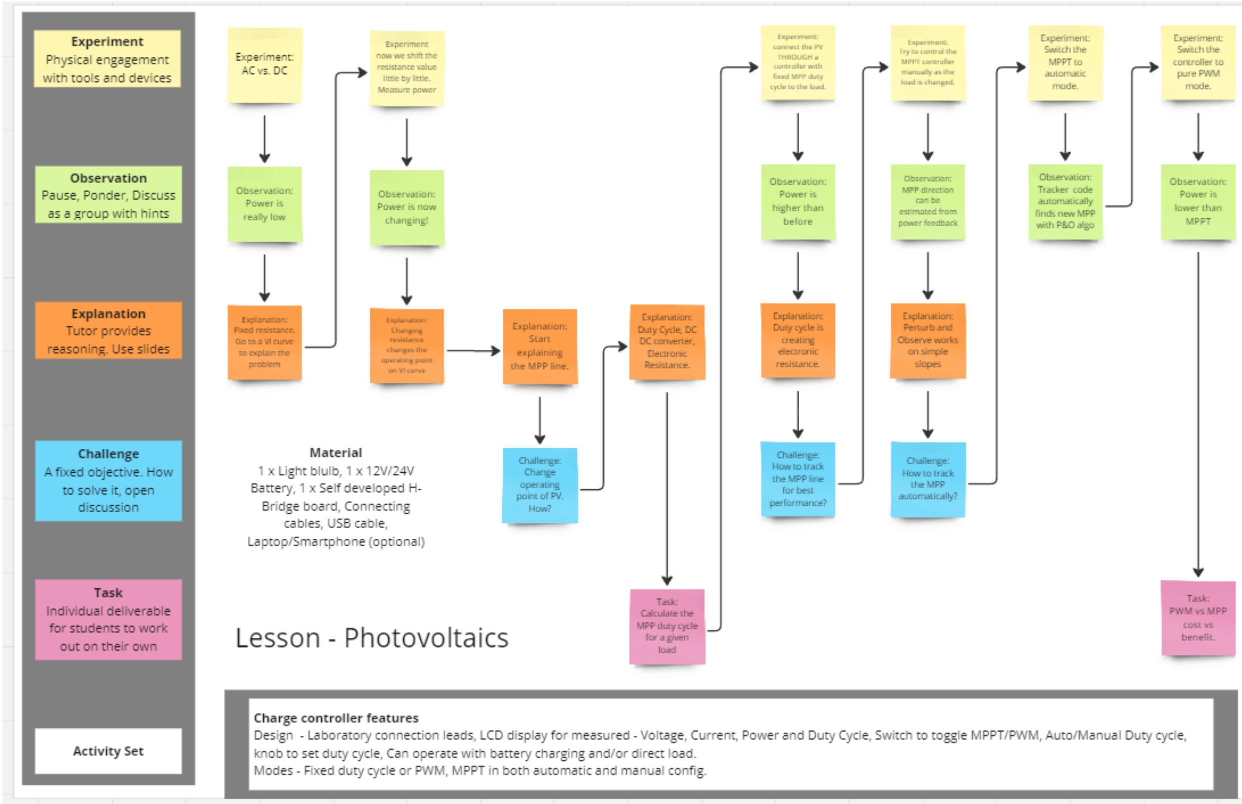

Figure 3: A possible lesson plan to teach PV charging fundamentals.

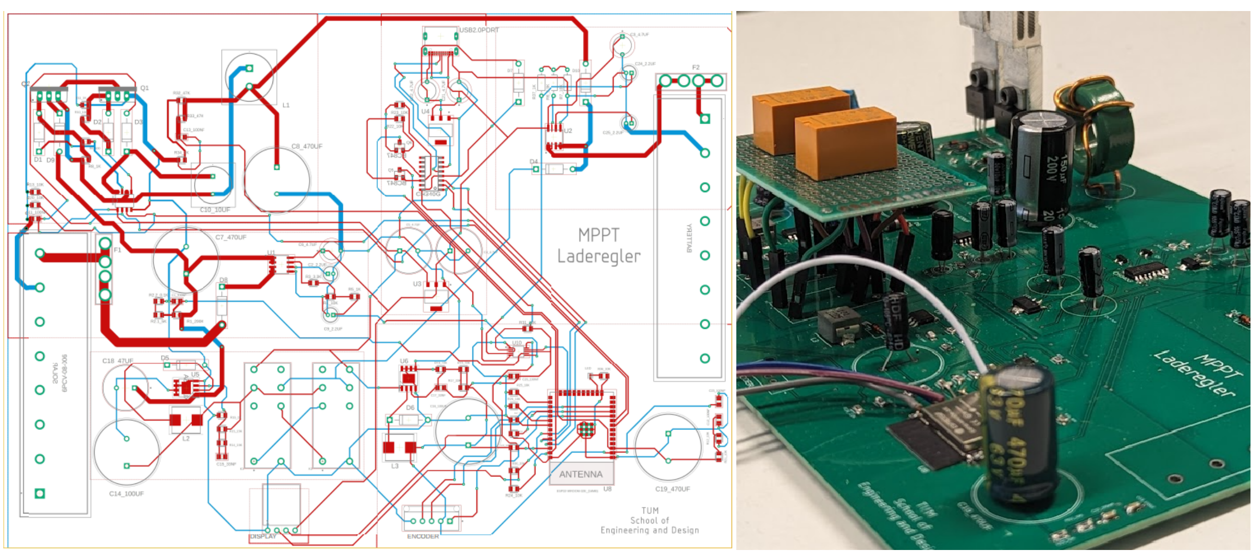

Figure 4: MPPT PV Charge controller prototype with adjustable elements for renewable energy education programs.

Power electronics circuits and PCB prototypes have been developed through other students projects. They can be upgraded and professionally manufactured through freelance development forums.

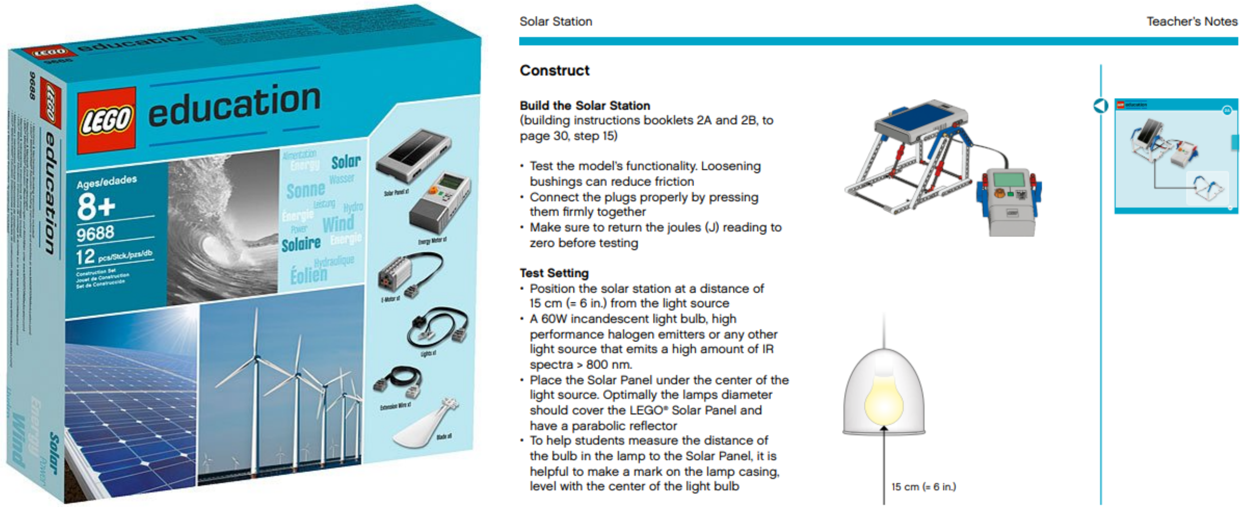

Figure 5: Lego Renewable Energy curriculum pack.

A typical student handout material could be inspired from the Lego Renewable Energy curriculum pack.

The education technology group could be inspired by the KiwiX - Offline Internet and Encyclopedia project and the Google Classroom family of tools with an API access for integration with other tools.

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