Using challenge-based approaches for teaching PV: case study of solar communities

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Abstract

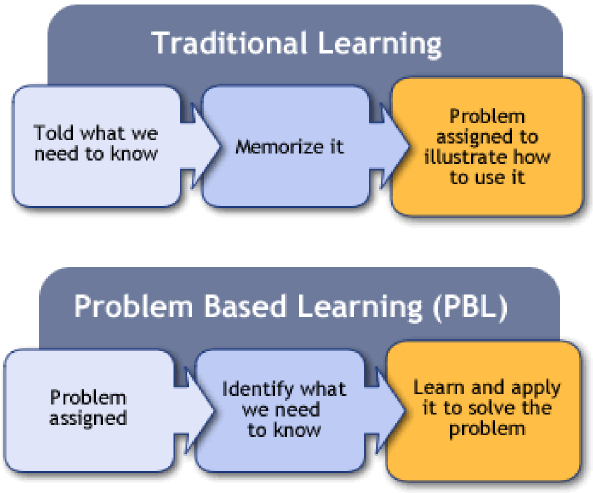
The traditional way of teaching, based on a centred approach around the teacher, must be questioned and new alternatives can be used to actively engage students. WE present here a challenged based approach applied to teaching of PV.

Keywords: photovoltaics teaching; challenge-based approach

INTRODUCTION

The society is not a static entity but it changes over time. This means that the students background knowledge and mindset is also changing. This has important consequences in the way higher education institutions (HEI) fulfill their mission. The traditional way of teaching, based on a centered approach around the teacher must be questioned and new alternatives can be used with very good advantages to actively engage students in the learning process.

One learning approach in HEIs, described as "challenge based", is to manage theory into the test of addressing real problems in collaboration with actors of society.



"Challenge Based Learning is an engaging multidisciplinary approach to teaching and learning that encourages students to leverage the technology they use in their daily lives to solve real-world problems." [1]

CHALLENGED BASED TEACHING

In Challenge-Based Learning, students are given challenges, resources, the opportunity to collaborate, tasks with multiple options for solutions and assessment based on real projects. Real-life challenges are interdisciplinary and this requires one to cross the boundaries encountered in single discipline-based courses. Inter-disciplinary approaches bring groups of students with different backgrounds together to understand the various angles from which a specific discipline looks at such challenges. They also help to develop interdisciplinary communication and collaboration skills. In addition, entrepreneurial/managerial skills and market knowledge can be used to enable students to develop technologies and services with the societal appropriation always in mind.

This approach implies changing the role of the teacher to that of a facilitator. Student paths then develop more around self-study and shared or individual experiences giving them the opportunity to explore areas of interest in more detail. Challenge-based programmes that focus on developing robust, coherent and holistic energy solutions, shift away from the more common focus on a single energy technology, or group of energy technologies that only cover a specific part of the energy system.

However, we must not forget that some degree of specialization must be kept. Meeting the need for specialization enhanced by a broader energy systems perspective can be achieved through the adoption of "T-shaped" skills-profiles into the developed courses/programmes. The essence of such model is that it combines essential, in-depth knowledge in specific, core disciplines (vertical bar of the T) with the broader perspectives of context and impact (the horizontal bar of the T) such as societal or technical aspects to support the energy transition.

The extent of such alternative approaches can be synthetized in

Case-based modules	**Challenge-based modules**
• Students analyze an existing case/practice emerging from a real-life problem. • they propose solutions, improvements to the existing ones or new/innovative solutions. Students acquire knowledge about real cases and the existing solutions to a problem.	• A combined approach of engineering, societal and business implications and impacts is adopted • Students are invited to work on a non-solved, real-life challenge/problem. • Students are expected to propose solutions/ approaches to solve the challenge/problem. The result is the proposal of a non-existing product.

SOLAR COMMUNITIES

As an example of this approach we designed a challenged based problem students have to solve as part of their assignments related to PV systems in a broader context [2].

Challenge

A group of neighbors in a condominium decided to study the opportunity of setting up a solar PV system to reduce their energy bills.

In the following meetings, they discussed the benefits and issues for individual and shared PV project. Your role in this project is to help on the decision, assessing costs and revenues of the two options.

Data available

The partners in the project included six residential dwellings, a small coffee house and the street restaurant. Luckily, they're all equipped with smart meters and have long term records of electricity demand (c.f. attached file with hourly electricity demand data for one year for each of the 8 meters).

The neighborhood is located in Lisbon (c.f. attached file with hourly solar irradiation data for the same period, measured in the plane of the roof, hence with the inclination and orientation of the future PV system).

The electricity tariff in force at the time of the study is basically a self-consumption mechanism where self-consumed electricity is valued at 0.17 €/kWh (as it avoids consumption at that rate from the grid, including taxes) while exported electricity to the grid is valued at 0.05 €/kWh (which is the retail price for electricity).

The costs of PV system equipment is … €/kWp and of the battery bank is … €/kWh, both including installation costs. The system technical details are listed in Table 1.

TABLE 1. RELEVANT TECHNICAL PARAMETERS

You may use a software tool to simulate the economic revenue, including running costs (battery replacement, etc.), for a PV system, given the specifications of the modules, inverter, etc.

Questions

Determine the optimum PV system/battery capacity for

a) each of the residential and service customers, in the scenario of individual PV systems

b) all residential dwellings, in the scenario of shared PV system

c) all residential buildings and the coffee shop, in the scenario of shared PV system

d) all residential buildings and both service costumers, in the scenario of shared PV system.

For each, indicate the return on investment and payback time as well as the self-consumption and self-sufficiency rates.

What is the expected outcome of the challenge

You will have to write a report for your friends explaining in detail your design calculations, based on the available data, and proposing the system configuration.

REFERENCES

[1] M. Nichols and K. Cator (2008), Challenge based learning white paper. Apple, Inc.

[2] J. M. Serra and M.C. Brito, Case study development: "Solar community: sizing a PV-storage system for aggregated consumers", UNISET Bridging Activity 2018

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