TRAINING AND DEMONSTRATION ON ECO-CONCPTION: AN EXPERIENCE OF ENST (ALGERIA) IN CLEAN TECHNOLOGY

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Abstract

The eco-design is an approach that clearly fits within the logic of sustainable development and concerns both services and equipments. From the start of the academic year 2017, within the objective of transferring skills to the School of Science and Technology in Algiers**,** Ecole Nationale Supérieure de Technologie (ENST d'Alger); and with the help of a cooperative project between Algeria and Canada, a team was set up. The team is composed of two researchers and four master's students chosen from the three specialities taught in ENST, which are: Management and Engineering of Maintenance, Engineering of Mechanical Systems and Embedded systems. The school has an environment with an already established level of expertise, know-how and networking contacts. This local experience in eco-design, would certainly be generalised latterly and would therefore like to share our experience in this paper (7 months from the submission date). Following our training at York University in December 2016, three final year projects were set-up. The first one is about life cycle analysis of a solar recharging station (engineering, designing and installation), the second project is about solar lighting " feasibility study of a new design of a Solar Lighting system". The last project concerns the analysis of alternative solutions for wireless internet "feasibility study of a WiMax/Wifi network powered by solar energy". This paper recapitulates the content of the three projects and their implementation.

Keywords : Eco-design, life-cycle assessment, solar street lighting , experimental multi-disciplinary teaching.

I. Introduction

All products have an impact on the environment during their life-cycle spanning all phases from cradle to grave, ranging from the use of raw materials and natural resources that can be not renewable, manufacturing, to disposal and recycling. Eco-design is a systematic way of considering all environmental impacts into a product right from the earliest stage of design, with a requirement of minimum impact.

It is very often difficult, or even impossible, to minimise all impacts at the same time. Thereby, a compromise is made (by weighing potential impacts) or choices are made.

Eco-design is a fundamental principle of sustainable development. It is for this reason why it should be progressively introduced into all programs in higher education[1].

II Human energetic activities: Two necessities requiring a change

The 20th century has been, undoubtedly, a century of environmental awareness, particularly the assessment of the limits of Earth capabilities. In response to this, humanity, those who have the means at least, has "invented" the notion of sustainable development. In 1987, the Brundtland's report (UNO Committee on environment and development) defined it as follows: « Meet the current needs, without compromising the capacity of the future generations to satisfy theirs». It is a matter of meeting the fundamental needs of the human beings: food, health, water, energy. From the summit of Rio (1992) to that of Montreal (2005) and that of Paris (2015), participants' nations tried to work out rules to reduce the impact of the human activities particularly as regards to climatic changes [2]. Face to this, one can be pessimistic, though it is still possible to limit damages. Let's remind us of the situation before climatic change, the rate of CO2 was less than 280 ppm. The report of IPCC (2001) foresees for 2100 a range between 520 and 950 ppm (Fig.1) [2]. The given last values do diverge principally because of humanity behaviour in the coming decades.

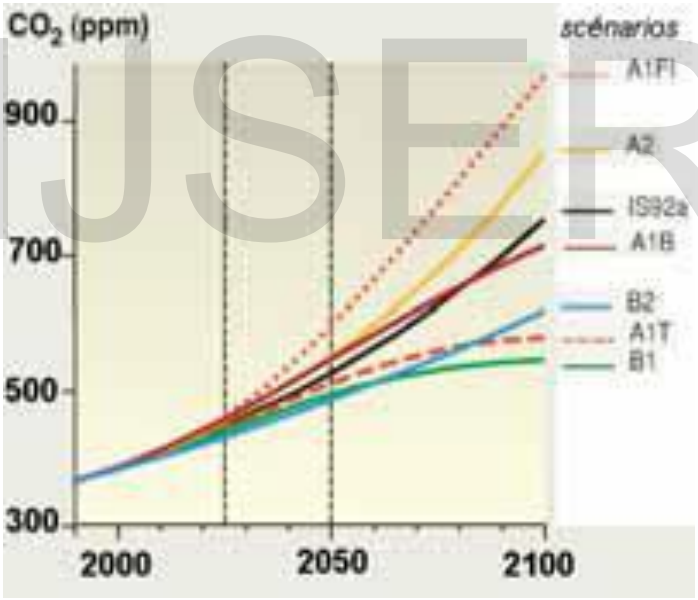

Fig. 1: Scenarios for the evolution of atmospheric CO2 concentration (details of scenarios in the IPCC 2001 report) [2]

III. Contribution of renewable energy

The contribution of environment and renewable resources to the main energy consumption is very modest and account for less than 20%. Considering environmental impacts and reducing

fuel dependence, governmental incentives have led to an increase share of abundant renewable resources. This source is usually free (Sun, wind, coal...)

Transportation is dominated by fuel and can profitably continue to do so by burning biofuel (biodiesel and bioethanol), with the advancement of technology, vehicles will consume hydrogen from renewable sources. However it would still take decades in order implement green and economical means of production and storage.

The final year projects, undergone in ENST, in close collaboration with a team from York University and a Canadian company ATS, fit to the context of using the sun as a source of energy. Photovoltaic conversion has a great advantage of being static and is therefore of excellent reliability with a very low maintenance.

a- Bike recharge station –Life Cycle Assessment : (LCA)

This product contains a battery; a source of energy, a bike equipped with an electric charger and other electrical sub-components. Life cycle simulation of the various constituents is divided into three stages:

the first stage is modelling: the software is allowed to determine environmental impacts during the life cycle spanning all phases, apart from the useful phase and transportation (raw material extraction, production of sub-products, manufacturing, ...etc).

The second stage: is the detailed description of the useful phase of the product, information on standby and active consumption and its lifetime are filled in.

Moreover, the set-up phase of the product is considered (including its packaging for example) and the maintenance phase (including components that need replacement during the lifetime). The last two points are to be filled in manually by the designer, ageing effects on component and sub-components are not treated in this project.

The last stage is the end-of-life of the product. A technical and economical optimisation study is obtained using specialised software called RETscreen, which is used for the analysis of green energy projects.

Training on this software was provided during our stay at York University.

b- Solar Street lighting panel:

The project is divided into two sections: the first one is concerned with electrical sizing, installation of photovoltaic panels on metallic support, lighting optimisation (internal and external). The second section is to carry a technical and economical

study using RETscreen as to evaluate environmental and economic impacts of the product. The panel is 50% manufactured locally in Algeria. The study of the feasibility of a new design of a solar lighting system. The study focuses on the energetic, economic analysis and environmental aspects.

C- Feasibility study of a WiMax/Wifi network powered by solar energy:

This project is in relation with the solar street lighting. it is about to find an alternative solution for wireless internet, and how to optimise the antenna positioning which is powered by solar energy collected from solar panel system.

IV. Acquired Experience

During the implementation of the three projects, the team has acquired a know-how in the field of photovoltaic. The charging station has been manufactured at 100% locally in Algeria (excepting bikes). The team has managed to establish a network of partners and local companies that work on photovoltaic's as well as foreign partners such as the Canadian team. This network has led to the signature of collaboration agreement between ENST and three local companies. Each partner has contributed in specific tasks in the production of the station, its components and evaluation. The structural approach will also facilitate technology transfer and know-how to other Algerian companies and research centres which will be associated in future projects.

Fig. 2. Solar charging built in ENST's team in Algeria that learnt by doing at York University's Keele Campus and now are experts at showcasing practical solutions to address climate change.

The approach “learning by doing" [3,4] has been adapted during all stages of the projects. The results obtained were so encouraging and have led to the creation of a research team within the school around this thematic. The team is led by the two researchers selected for the project

V. A practical learning situation in ENST

In science and technology, laboratory work has an important place, learning by doing, is a legacy from John Dewey(early 20th century) [5]. At ENST, laboratory work takes up to 50% of the student teaching time during all the university program. In addition, visits to industrial sites and internship (in 1st, 2nd and final year) represent up to 30%, which make a percentage sum of 80% allocated for practical situation of learning.

There is no learning situation without having simultaneously, an action and thinking on the action. Teaching, meaning learning, consists of making the student face to a double activity, leading him to do, to act, and to practice, in interaction with the physical and the social environment, and at the same time, leading to think, to ask questions, to make sense of what he/she is doing.

The carried out projects at ENST belong to this vision. The students who participated to the realisation of the different projects, are issued form three specialities (Maintenance, mechanical and electrical engineering)

As in science and technology, the teacher is at a time an engineer, a technician and a specialist, and educator, juggling diverse tool boxes in order to elaborate the daily practical situations, knowledge and outcomes mobilization for the students. This is the biggest challenge for the peer mentor who plans, supervises and steers the ongoing and the demonstration of these multidisciplinary disciplines.

It took the students a while before grasping the issue. Their reaction is very natural. Despite the training week in York University on renewable energy, the students didn’t have sufficient and necessary knowledge for identifying the tasks required for the project.

It can also be said that students have the necessary knowledge but had difficulties in mobilising their knowledge. It wasn’t until achieving few visits to company sites working in the field of renewable energies. That plan was elaborated for the project (the charging station

and the solar lighting system). The students have spent a placement of 5 weeks from the 14/02/2017 till 30/03/2017.

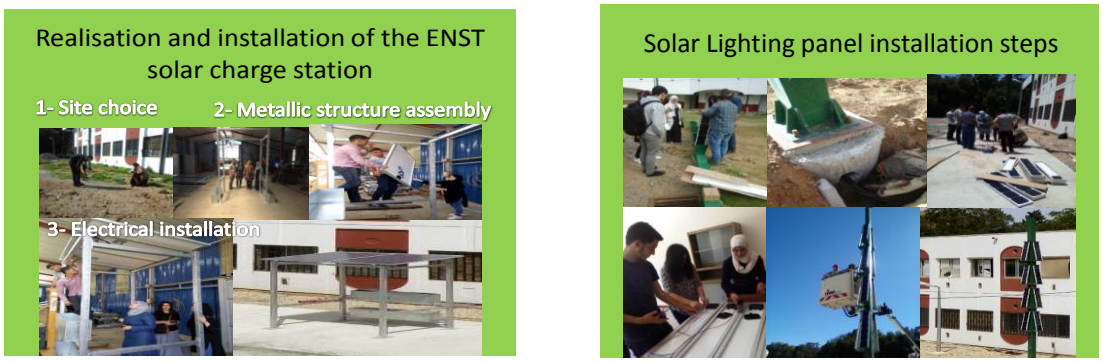

Fig.3. Solar charging and solar lighting panel installation steps in ENST's team in Algeria
This figure shows realization and installation steps of both solar charging station and solar lighting panel by ENST's team (students and supervisors).

This experience of exploring the industrial environment, allowed us to get an idea of the local solar market in Algeria. It is worth mentioning that the local market is only based on personal initiatives. Figure 4 confirms the weakness and the size of the Algerian solar market, as compared to other countries such as Canada, Germany and China.

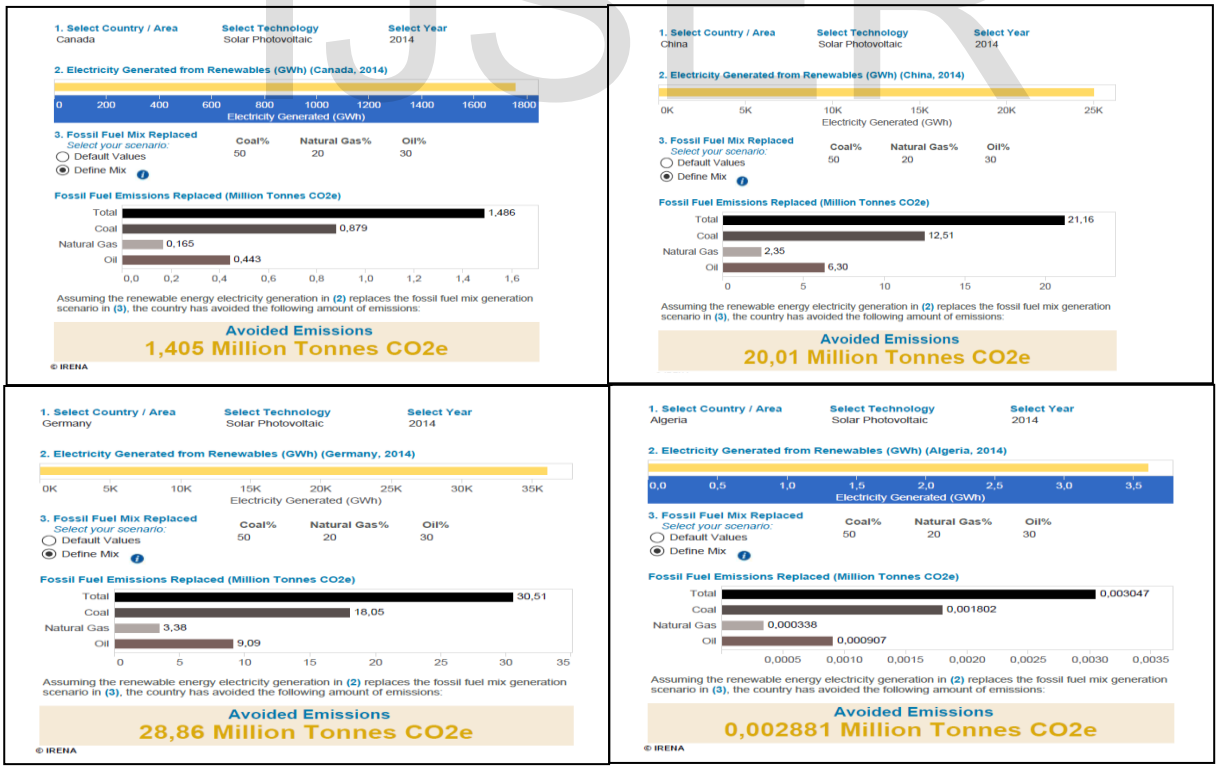

Fig. 4: Electricity generated from solar photovoltaic technology and its contribution to the diminution of CO2 emission in Canada, China, Germany and Algeria (IRENA 2014).

It is evident that China and Germany are leaders in this field owing to the development of the solar market and the availability of the photovoltaic technology in these countries in addition to the political choices dictated by scientific research.

A social and economic study of these demonstration projects was carried out in order to consider the second stage of the collaborative project, which is to supply the ENST at 100% in solar energy (renewable), just like the Pablo Neruda School situated in Chilli, an example of internalisation and knowledge mobilisation strategies, an approach “learning by doing” adopted by the SI research team at York University.

VI. conclusion and recommendations

The objective of our contribution to these demonstration projects is the improvement of the relationship between "teach" and "learn" at ENST, and the incorporation of the renewable energies culture in the training programs of our future students. The contribution of the Canadian part is for the internationalisation of the educational experience "Experiential Learning Approach" in collaboration with organisations leaders in renewable energies (IRENA) for the benefit of the countries of the Latin America and the Middle East (Middle East) [3].

In this article, we have presented a model for the design and implementation of an education system, based on the consideration of a scenario or a real situation of learning. Following this strategy, teachers and students have been confronted with several difficulties mainly due to lack of facilities. Learning is about setting out and implementing all the means that allow the achievement of the learning process involved by the knowledge to be acquired. The implementation of these projects is considered as carrying out a set didactic process and the setting of guidelines in terms of unexpected events and perturbations.

The major unexpected event faced during the execution of these projects is the manufacturing of the charging station, at 100%, by an Algerian team using local products available in the Algerian local market. This was a real challenge to be raised by the team of the charging station. The non-availability of some products such as electric bikes in Algeria and the far-distance of Canada have pushed the team to seek alternative solutions in the Algerian market (electric wheelchair instead of the electric bike). These were real situations of disturbance and crisis within the Algerian charging station team.

The difficulty encountered by the solar lamp post team is the absence of the budget for the purchase of the optimization software (lighting and wifi network and characterisation materiel). Face to these situations, the two teams have proven a sense of thinking and implementation solution as a function of the available means while respecting deadlines for the completion and the specifications established by the Canadian part.
The students learning is on one hand one of the objective of the project and on the other hand a mean of evaluating its implementation, in forming leaderships (teachers and students) in the field of renewable energy.

The results obtained in the framework of these projects have encouraged the administration of the school to create a research team around the core of renewable energy formed by the two researchers.

At last, the project experience has allowed us to make the following recommendation: non-governmental institutions (volunteers) and international organisations can play an important role in supporting financially the collaboration programs for the protection of the environment. This may contribute to the inclusion of the concept of renewable energies and sustainable development in all programs of higher education and in the education of the citizens of tomorrow.

Thanks

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