Too Cool for School: Engaging Students with Energy Efficiency

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ABSTRACT

Delivering energy efficiency through "energy conservation measures" and a project-based approach has been a hallmark of the energy service company (ESCO) market and utility rebate structure for decades. While it isn't the best way to deliver energy efficiency in all market segments, it has been successful in small commercial and K-12 facilities.

However, as Plug Smart has engaged with several school districts in the past 5 years, we have begun to see the value in moving beyond a project-based approach in which we install a few energy conservation measures and then move on to the next client or building. Using the energy efficiency measures we install as a starting point, we aim to provide schools with the hardware and software front-end to explain to students the details and benefits of the project and how the project fits into a broader energy picture.

This paper will present examples of how we have been able to increase awareness of energy efficiency by bringing it into a school-learning environment. Using web-based dashboards that tie into a building automation system, students and teachers are able to see what's happening at their own school in real time. From demand control ventilation and condensing boilers to simple night temperature setbacks, there is a wealth of possible topics that can engage students and bring about a greater sense of energy awareness that will be critical to finding the next generation of solutions to climate change and clean energy advancement.

Introduction - ESCOs Go to School

Energy service companies (ESCOs) have been a popular avenue for clients who are interested in achieving energy savings, since the 1970s (Gilligan 2011). ESCOs implement energy projects which generally pay for themselves through the energy and operational savings they create. ESCOs traditionally focus on implementing discrete, often capital-intensive "energy conservation measures" and then move on to the next client or building. In addition to developing the energy projects, obtaining financing has also became part of the ESCO model. By providing or facilitating financing, the ESCO typically assumes some risk for the energy savings. While there are many different business models, two common approaches are shared savings and guaranteed savings.

In both scenarios, the ESCO will engineer an energy solution, along with estimated energy savings, for a client. They will also often help the client find a way to finance the project. With shared savings, the client will pay the ESCO all or a portion of the estimated energy savings in order to pay for the project, which is done through the ESCO. With guaranteed savings, a third party provides financing, but the ESCO guarantees the savings, so that if the project does not result in the contracted amount of savings the ESCO will be financially responsible. While shared savings was once more common, guaranteed savings has become the dominant method of ESCO projects, particularly in the public and institutional markets (Gilligan 2011). The savings guarantee provides the client with peace of mind in knowing they will be made whole on their loan obligations through the energy savings.

Ohio HB 264

In Ohio, a program known as House Bill 264 (HB 264) allows public K-12 schools to take out loans to fund energy efficiency projects without resorting to a ballot measure. In order to qualify for HB 264, the energy project must be at least budget-neutral in a 15-year period. That is, it must have a 15-year or less payback, including financing costs and certain restrictions on how much maintenance and operations savings can be counted (OFCC 2016). In addition to HB 264, another program called the Energy Loan Fund allows HB 264-commpliant projects to receive financing at below market rates (OSDA 2015). The Energy Loan Fund is a competitive loan program open to businesses, non-profits, and public entities in order to promote energy efficiency and advanced energy projects.

These programs remove a key financing barrier to energy efficiency for this market segment and create a demand for energy services. Not only are ESCOs meeting this need, the increased demand allows ESCOs to develop expertise in school building energy efficiency. With demand comes competition, which drives ESCOs to develop more targeted services to schools, which is the focus of this paper.

Broader Reasons for Energy Efficiency

The ESCO model has been fairly successful at realizing energy savings through implementing energy projects, especially in the commercial, institutional, and public sectors. The ESCO model of delivering verifiable energy savings is driven by utility incentive programs and state efficiency targets, which focus primarily on direct energy savings[1].

However, different types of organizations have different reasons for pursuing energy efficiency:

- **Utilities** (most typically investor-owned utilities) are often mandated to achieve a certain amount of energy savings, largely because energy efficiency is the least-expensive way to meet new generation needs (Molina, et al. 2015). However, environmental and societal benefits are also often cited in the need for utility involvement and incentives (Taylor, Trombley, and Reinaud 2012).
- **ESCOs**, who are mostly for-profit entities, and supply technical and project development skills in order to increase company or shareholder value.
- **Financing agents**, who may be for- or not-for-profit, also expect a healthy return on investment. In the case of non-profit entities, social and environmental responsibility plays a larger role.
- **Schools** are driven by the need to reduce operating costs in the face of often-tight budgets. While the savings are primary, schools are also motivated by environmental and community benefits of energy efficiency and clean energy. Other benefits to schools are increased comfort and higher quality classroom lighting – which can improve student focus (Leading Edge Design Group 2015).

[1] Many programs do have educational components, but the focus remains on acquiring energy savings. This is less true in the Pacific Northwest, which has for some time had a greater focus on market transformation. For a detailed discussion of different types of state and utility programs see Taylor, Trombley, and Reinaud, 2012.

Schools also look for ways to engage students and communities around infrastructure projects in order to improve the community and enhance students' education experience. ESCOs, who are looking for ways to distinguish themselves, are beginning to find ways to tie their technical energy projects to classroom learning.

While the financial bottom line greatly influences organizational decision making, many of the entities involved are also interested in the environmental and community benefits of energy efficiency.

Plugging Students In

Juice Technologies Inc, dba Plug Smart, is a full-service energy services company based in Ohio. Through the HB 264 program mentioned above we have implemented energy efficiency projects in over a dozen school districts across Ohio since 2012. Plug Smart, recognizing the value in engaging this market segment, has begun to develop and implement outreach strategies to schools, called *Plug Smart Connect* (PS Connect). Figure 1 below shows the planned scope of PS Connect.

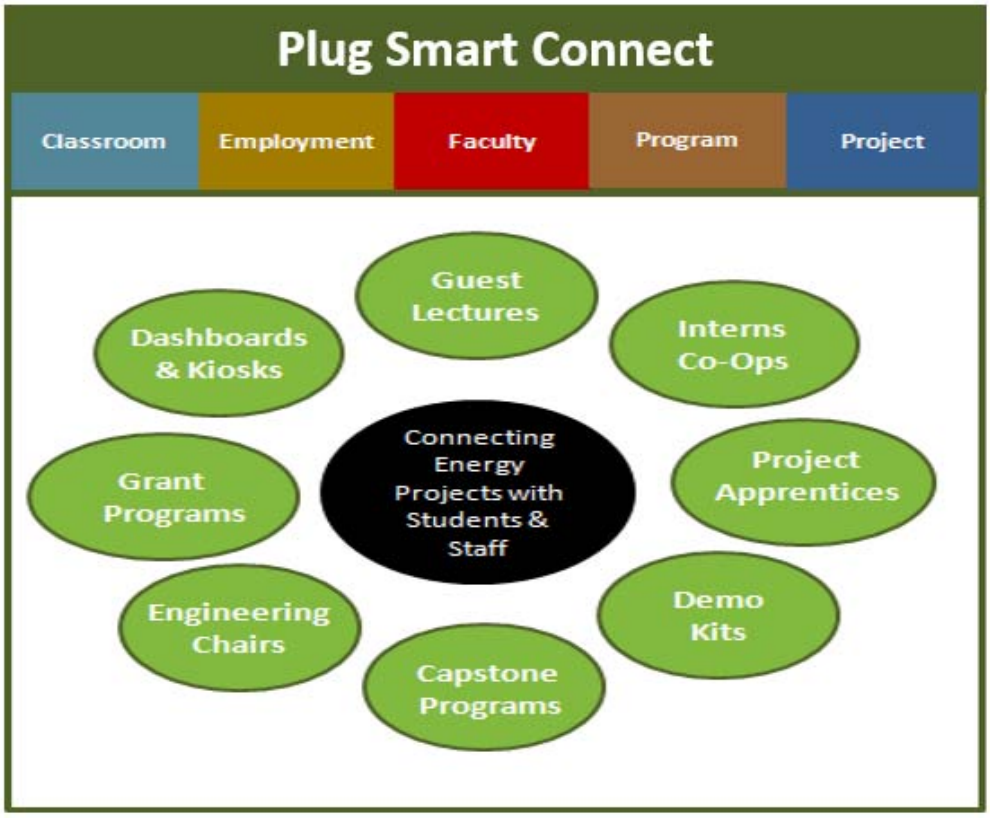

Figure 1. Visual overview of the Plug Smart Connect program under development. *Source*: Plug Smart internal document 2015.

When working with a school district, we present them with a number of avenues of engagement and let them choose which option would be most beneficial under their circumstances. Because we only pursue projects that are of interest to each school, we have not

to date had an opportunity to implement everything in Figure 1. However, we have implemented several components of the PS Connect scope as discussed in the next two section. PS Connect is a work in progress, and we continue to develop better ways to better integrate our energy projects with the technology and resources to bring energy education to the classroom.

The boxes at the top provide high-level categories of involvement, while the circles on the lower half list more specific engagement methods. The high-level elements include:

- *Classroom* – instruction and learning opportunities
- *Employment* – project participation and internships
- *Faculty* – energy conservation toolkits and sponsorships
- *Program* – grant program participation
- *Project* – sponsored energy conservation measures

While PS Connect is more geared toward the K-12 market, aspects of our work in this area can be largely put in two groups: outreach at the University level and the K-12 level.

Universities and Cooperative Education

When working with colleges, Plug Smart has sought ways to engage with students. One way to reach out to the campus community is setting up interactive kiosks that display energy information such as energy production from the university's power house, energy avoided by production at on-site solar arrays, and other information on sustainability and water conservation, as shown in Figure 2 below:

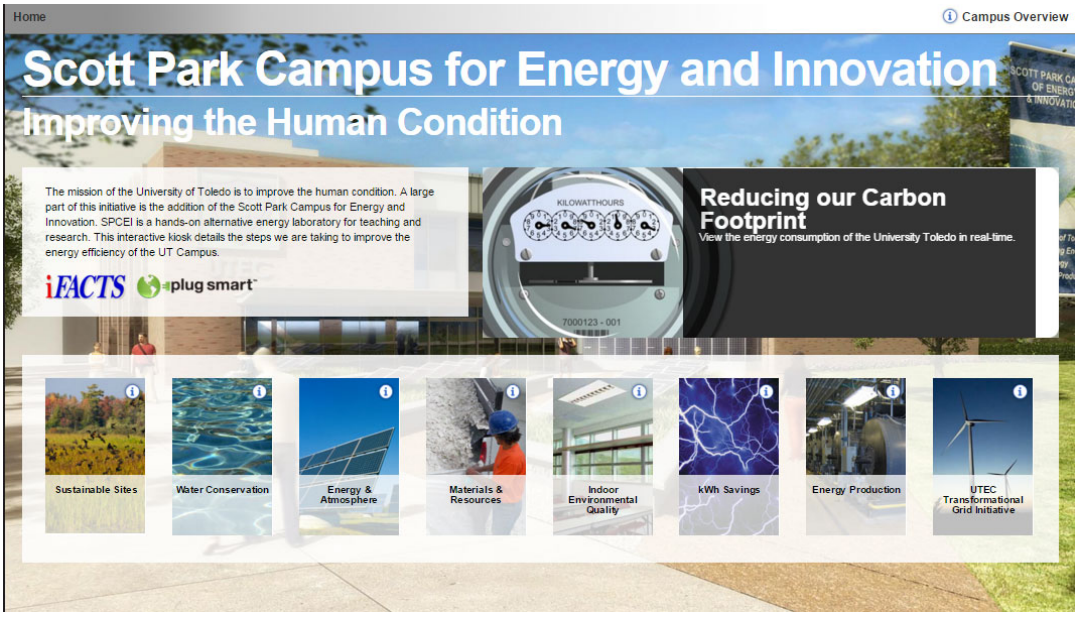

Figure 2. Interactive energy kiosk located at The University of Toledo showing the effects of solar energy production and efficiency. *Source*: Computrol 2016.

Another way to involve university-level students is to hire them as co-ops or interns. Plug Smart regularly hires engineering students from nearby University of Dayton and The Ohio State University, which both have excellent engineering programs with a focus on energy efficiency and clean energy. Plug Smart's philosophy on co-ops and interns is to hire excellent students and make them part of the team to support the engineering staff. From participating on energy audits to developing software tools, there is virtually nothing we won't have a co-op do. We even sent an intern to troubleshoot (and solve) an issue with a solar array we installed at a local school. Following the students' interests and abilities lets us utilize their individual skill sets to solve problems on the behalf of our clients while developing the students' expertise. When working on projects for a university, we also make an effort to hire students as interns to help with the analysis or implementation. On two occasions we've taken on two to four interns from universities we were working with to aid in data collection and energy auditing.

Finally, Plug Smart engages with universities at a higher level by making our engineering team available to be a resource to students and faculty. For example, Plug Smart engineers aided students in a senior-level capstone design class. Our engineers assisted a team of students tasked with performing a solar PV feasibility study for Ohio Northern University. Plug Smart staff were available via conference calls, providing resources (such as where to locate relevant studies), and insight into technical issues faced by the group.

K-12 Outreach

Reaching out to university-level students is fruitful because the barrier to understanding is relatively low – they have an educational base that allows them to grapple with some of the more complex issues surrounding energy efficiency. However, it is also important to reach out to younger students. Research shows the earlier and more often students are presented with information the more likely they will retain the information (Pashler et al., 2007).

Our PS Connect program is still in development and is in the early stages of implementation. At two school districts, after completing the energy efficiency project, we provided the school with a web-based dashboard detailing each school's current energy consumption rates and trend data against a baseline, as shown in Figure 3 below. A third school was provided with a tablet PC to access the dashboard, although this was primarily geared toward a facility and administration staff.

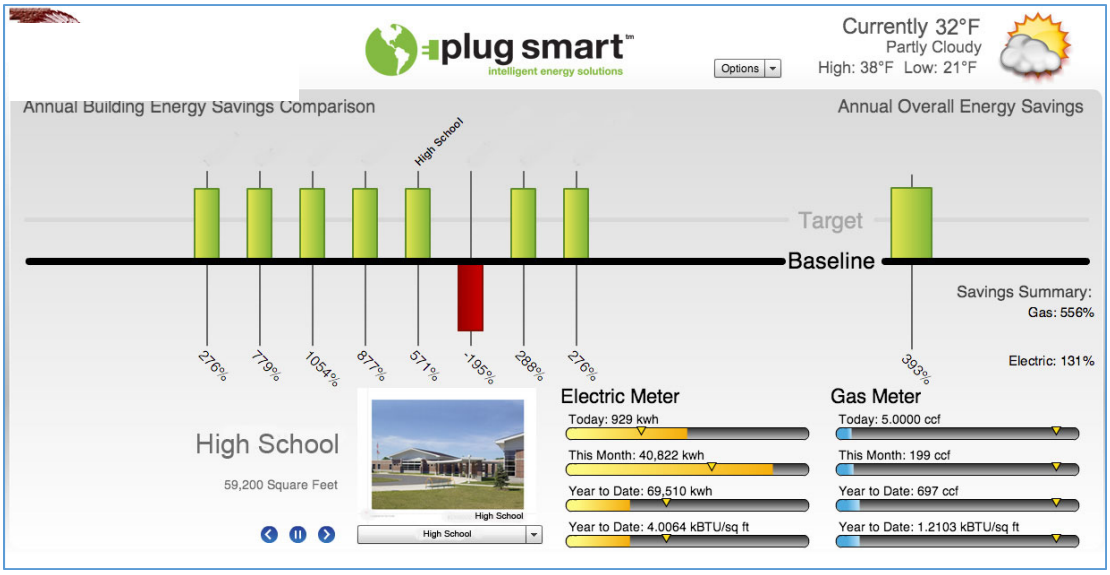

Figure 3. Energy dashboard provided to a local K-12 school district showing electricity and natural gas usage. *Source*: Plug Smart internal document 2013.

This technology is the infrastructure that gives us the ability to engage with students and staff. The energy dashboard was made available via webpage and a newsletter explaining the energy projects completed and the dashboard was circulated to school faculty and staff. In one school Plug Smart staff presented an overview of the implemented energy project and general energy efficiency themes to teachers and staff. With these first few schools, we did not collect data on usage of the dashboard or users' opinions, but hope to gather more data for projects moving forward. Knowing how students, faculty, and staff use and respond to the information provided will be critical in improving the systems and measuring the overall effectiveness of such programs.

Future Developments. As represented in Figure 1, more development is needed on our PS Connect program to fully integrate an understanding of energy into the classroom. We plan on expanding the program in a number of ways. We would like to better build on the dashboard, making it more interactive and accessible to students. For example, after presenting to faculty and staff, we would present directly to students, giving them a hands on demonstration or tour of some of the energy efficiency projects installed in their school. Plug Smart staff could also serve as a resource to educators trying to integrate energy and energy efficiency issues into curricula and projects.

Other Programs Bringing Energy into the Classroom

In addition to ESCOs designing outreach to schools, there are a few other Ohio organizations engaging students and staff at the K-12 and university level:

Ohio Energy Project. The Ohio Energy Project is a non-profit organization which helps educators develop curriculum, workshops, and projects to teach students about energy and energy efficiency at school and at home. Some projects include the Energy Bike, which gives

students a concrete understanding of energy use by using a stationary bike to power different kinds of light bulbs; home energy kits, which allow students to implement simple energy efficiency measures at home such as LED lights and low-flow shower heads; and youth leadership summits, which empower students to conduct their own programs and teach other students (Ohio Energy Project 2016). The Ohio Energy Project is funded largely through electric and gas utilities and other corporate sponsors.

Industrial Assessment Center. The Industrial Assessment Center (IAC) at the University of Dayton (UD) is one of 24 centers located at engineering universities across the country. The program funds a team of graduate and undergraduate engineers to conduct no-cost energy assessments for local small and medium-sized manufacturers (DOE 2016). Because the IAC directors who lead the teams are professors, they have (at UD and other universities with IACs) developed classes that teach the fundamentals of energy efficiency in industrial and commercial buildings. This leads to a focus on efficiency that would otherwise be harder to implement and sustain, and it reaches many more students than those directly engaged in the IAC.

Conclusion

Implementing large, capital-intensive energy projects, while relatively easy to measure, is not the only way to improve energy efficiency. There is much to be said for longer-term approaches such as market transformation and educational initiatives. Bringing energy efficiency into the classroom, whether at a middle school or a university, can have large effects on future energy use. It also gives energy service companies a chance to differentiate themselves in the market, offering targeted programs to K-12 and universities. These programs help schools save money, states and utilities meet energy savings targets, and students learn more about the wide world of energy and energy efficiency.

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