# Reducing electrical energy consumption through behaviour changes

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## Abstract

**Purpose** – The purpose of this paper is to look at the effect of human behaviour, and efforts to change that behaviour, on electricity consumption in a high school setting.

**Design/methodology/approach** – The study uses a mixed methods design of interviews and historical electrical use data to assess two treatments impacts on electrical consumption over time at two Fort Collins high schools.

**Findings** – Both treatments, the energy efficiency awareness campaign and the energy efficiency charrette, were found to have a positive impact on decreasing levels of electricity consumption. Unfortunately, these decreases lessened over time. The key attributes of communication, motivation, and leadership were identified as necessary at the high school facilities level to ensure long-term success in decreased electrical consumption.

**Research limitations/implications** – The implications of this research focus on awareness of energy use in public schools and how to use awareness as a cost-effective tool in decreasing electrical consumption. The limitations are the inability to isolate HVAC consumption loads and the small study size. However, this is one of, if not the first, effort to use awareness campaigns and charrettes in a high school setting to decrease electrical use. Additional research would answer questions like: how to increase the charrette impact time; could these programs be adopted district wide at all grade levels; how could energy awareness be institutionalized so periodic charrettes are not necessary? Limitations include the inability to isolate heating and cooling electricity loads from the data.

**Originality/value** – This study is the first of its kind and has value to facilities management personnel, custodians, faculty and administration members, particularly in a high school setting. This research provides a framework and potential guidance for a school organization to conserve electrical energy and achieve cost savings and environmental benefits.

**Keywords** Energy conservation, Human behaviour, School, Electricity consumption, Sustainable facilities management

**Paper type** Research paper

## Energy usage in school buildings

Educational facilities use approximately 14 percent of all energy consumed in US non-mall buildings, third behind retail services and office buildings (USEIA, 2010). There were 1,696 K-12 schools in Colorado in 2011-2012 with 854,265 students and 49,120 full time equivalent teachers (Colorado Education Statistics, 2012). This is a total of 903,385 people or just under 18 percent of the 2012 estimated population of Colorado (United States Census Bureau, 2013). There are over 55 million students that go to school every day in the USA

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making schools a major component of the US commercial building stock's energy usage (Kats, 2006). In order to maximize energy savings in school buildings facilities managers need to understand both building and user behavior. While much of the focus on building efficiency is on systems the role of occupant behavior also has an impact on energy usage. This study will look at the development and implementation of a social awareness program at Poudre high school in Fort Collins, Colorado to measure its effectiveness on energy usage. The awareness program was based on a similar program at Rocky Mountain High School (RMHS) in Fort Collins, Colorado during 2004-2009 which indicated significant change in energy use could be effected by changes in occupant behaviors.

### *Poudre school district*

Of the 178 school districts in Colorado, Poudre school district (PSD) is the ninth largest district. The district is made up of 30 elementary schools, ten junior high schools, five senior high schools, three charter schools, two early childhood centers, and 21 other administrative and maintenance facilities. The district has been working for over a decade to achieve building energy efficiency by creating sustainable and energy efficient buildings making them a leader in energy efficiency (Schelly *et al.*, 2010). PSD administrators and energy management staff frequently travel across the country to share knowledge with other school districts in an effort to help others reduce energy consumption based on their program successes.

## Purpose

### *Problem and opportunity at PHS*

The PSD, in Fort Collins Colorado, aggressively continues to lower its energy use. To help achieve this end the PSD diligently works to increase its institutional effectiveness by creating high performance, sustainable, green school buildings. Through education, technology, and social awareness campaigns, PSD has achieved substantial reductions in energy usage and increased overall environmental consciousness of building occupants with the help of a variety of sources including energy star, the United States Green Building Council (USGBC), and human behavioral change. Faced with budget concerns PSD looked for innovative ways in which to decrease energy use. In addition to facility upgrades the district considered using a social awareness campaign to increase building occupant awareness of their impact on energy use. The goal of this campaign was to maximize potential energy savings of the buildings and systems through the increased awareness and resultant occupant change.

In an effort to measure the impact of an energy focused social awareness program, PSD identified PHS, built in 1963 and remodeled in 1995 and 2005, as having a high potential for additional increased energy efficiency. The thought was that once the high priority, "low hanging fruit", energy efficiency fixes were implemented, additional changes in occupant behavior may be needed to fully realize all potential energy savings in a given building. To this end it was suggested that a social awareness campaign be instituted at PHS similar to a previously successful program at RMHS, also in the district. By linking energy consumption to environmental impacts, building users were able to make a direct connection between building performance and the environment. Significant changes occurred at RMHS as a result of this program (Schelly *et al.*, 2010). RMHS engaged in a variety of efforts to increase energy conservation behaviors between 2004 and 2009.

*Environmental footprint awareness at RMHS*

Beginning in 2004, RMHS initiated a variety of efforts to engage building users in conservation oriented behaviors. All building user groups were targeted. By examining their own routines the custodians started keeping room lights off except directly before, during and directly after school hours (Schelly *et al.*, 2010). The custodians then encouraged other teachers to examine their behaviors and look for additional ways to conserve. This resulted in keeping the gym lights off on days when classes were being held outside. The environmental science teacher found additional ways to educate students and teachers about energy conservation. Energy conservation successes were communicated in a variety of ways including student created video announcements, the school newsletter, and through posters that translated energy savings into more tangible things like dollars saved or pounds of carbon emissions reduced (Schelly *et al.*, 2010). The largest reduction was seen in the 2006-2007 school year, when the school used 27 percent less kWh/ft$^2$ than was used in the previous academic year (Schelly *et al.*, 2010).

*Opportunity at PHS*

To make a comparison of results between RMHS and PHS possible the attributes of the schools and population needed to be similar. Both schools had similarities in building size, history, student population, and retro-commission treatments (Table I). Based on the energy savings achieved at RMHS PSD administrators were convinced that additional potential energy savings were possible at PHS if similar behavioral efforts could be encouraged based on the outcomes of RMHS.

## Research questions

*RQ1.* Can an energy efficiency charrette, an energy conservation planning workshop that engages faculty, students, and staff from PHS, help to initiate an active awareness campaign similar to the efforts at RMHS and result in substantial reductions in electrical energy consumption at PHS?

*RQ1a.* If reductions are achieved could subsequent follow-up sessions effectively act as a proxy for a commissioning process at a school?

| | |
|---|---|
| Retro commissioning treatments | Both schools had similar treatments during FY 2000. Therefore, the way that the HVAC operation of each school was affecting energy consumption was not different |
| Square footage | RMHS – 291,893 ft$^2$<br>PHS – 277,143 ft$^2$<br>5.05 percent difference |
| Building histories | Both schools are similar in age and history to assume they are comparable<br>RMHS – originally constructed in 1973, remodeled in 1994-1995<br>PHS – originally constructed in 1963 (142,000 ft$^2$), remodeled in 1995 to increase to current square footage |
| Occupant counts | Both schools have about the same student enrollment numbers (1,700 with some slight variations over time) |

**Table I.**
RMHS and PHS similarities in treatments, size, history, and occupants

*RQ1b*. If there is an impact from an awareness campaign how long does it appear to last and would it need to be continual in nature to ensure ongoing reductions in electrical usage?

The objective of the research is determine if an active awareness campaign at PHS that is similar in nature to the efforts at RMHS could result in substantial reductions in electrical energy consumption at PHS. The awareness campaign used a charrette process to help initiate the active awareness campaign.

### *Energy efficiency charrette*

A charrette is a workshop where key stakeholders generate and discuss ideas in a design process and participants are encouraged to offer design ideas and solutions to problems that are outside their areas of expertise (Lindsey *et al.*, 2009). The energy efficient charrette is an energy conservation planning workshop that engages faculty, students, and staff from PHS in an effort to increase participant awareness. If the active awareness campaign is found to be an effective tool in reducing energy use the length of time this impact covers as well as how to continue the impact will be addressed.

Prior to the PHS charrette, focus groups that included teachers, students, administrators, and custodians from both schools were used to determine what social, organizational, and/or cultural characteristics created an energy efficient practice. The focus group research identified several key social factors and motivators that were instrumental in facilitating change at RMHS thus providing a guideline for planning the charrette at PHS. In sustainable building projects, charrettes consist of a collaborative brainstorming session to identify key design components and to bring innovative design strategies to the table. The half-day charrette at PHS involved students and staff and administrators from PSD and graduate students from the Colorado State University Department of Construction Management. Groups were formed to discuss main social factors found to increase energy conservation at RMHS: leadership, communication, and participation/motivation. These groups discussed their respective category and joined the other groups several times before major ideas, consistent to the three groups, were synthesized and discussed in a final group session.

## Research methodology

The research used a case study utilizing mixed methods. The comparability of data from both RMHS and PHS was assumed to be proper based on the building attributes discussed above and shown in Figure 1. It was further assumed that proximity of the two buildings in Fort Collins, Colorado did not add any significant impact to the electrical demand based on weather. Data was collected from an analysis of electrical use data at both schools, interviews of teachers and staff at both schools, and from reviewing previous reports from the charrette and the focus groups at both schools. There were two main areas of concern for the longitudinal data used in the study: electrical use and temperature fluctuations. The steps taken to make this time series of data comparable include actual kWh usage to negate electricity price fluctuations and the use of heating and cooling degree days to account for changes in electrical demand based on weather.

### *Collection and analysis of electrical usage data*

The electrical usage data for both PHS and RMHS was compiled for a ten year period. The data used was from the seven years prior to the charrette (October 2000-October 2007)

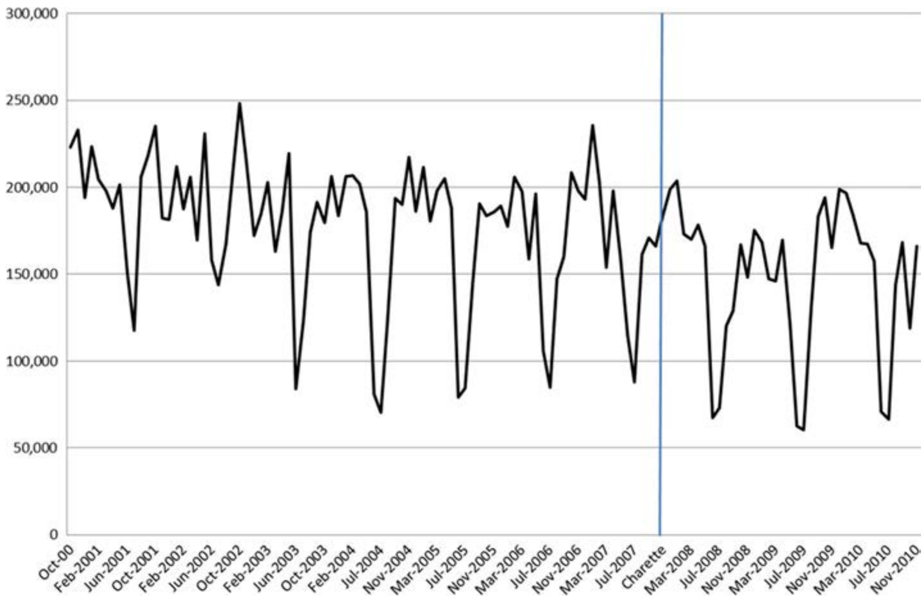


**Figure 1.**
PHS adjusted kWh consumption before and after active awareness campaign, fiscal years 2000-2010

and for three years after the charrette (November 2007-November 2010). This data range was chosen because it covered the time period when PSD instituted district wide automated systems, retro commissioning practices, the awareness campaign at RMHS, the PHS awareness campaign, and data after all the interventions occurred. The usage data from both schools over this ten year timeline should provide insight into the impacts of each event, if any, and any resulting change of electrical usage over time as a result of the awareness campaign intervention.

*Variations in weather*. To account for the weather variations the use of degree day data (Weather Data Depot, 2013) adjustments was used to normalize the longitudinal data to account for the temperature variations from year to year. For this study, the degree day data was compiled for the years 1999-2010.The average degree day (the sum of all heating and cooling days) value for each month in the time period 1999-2010 was calculated (1). The difference between the actual total degree day value for each month and the average value was then calculated as a percent (a):

(1) (Actual degree days − Average degree days)/Actual degree days = % difference

(a) $(737 - 937)/737 = -27\%$ (rounded to nearest whole value)

This percent difference was then applied to the total kWh consumption for the corresponding month to account for weather variations across time (adjusted kWh). The inability of being able to isolate the run times of the HVAC equipment from the other electrical loads in the buildings for this study was overcome by using a percentage HVAC usage factor. While this is a limitation of the study it can be assumed that the HVAC run times for the buildings are similar due to building size, location, number of building occupants, and centralized programming and HVAC scheduling performed from district headquarters. The PSD energy management staff determined that the electrical consumption for standardized HVAC operations at both schools was 40 percent of the total kWh consumption. This "Adjusted kWh" was calculated using the following formula (2). The inclusion of the percentage calculation calculated previously is shown in (a):

(2) $[(0.4*\text{kWh})*(1+\%\ \text{difference})]+(0.6*\text{kWh})=40\%\ \text{Adjusted kWh}$

(a) $[(0.4*199,221)*(1+(-27)\%)]+(0.6*199,221)=177,576$

There was no way to isolate the run times of the HVAC equipment from the other building electrical consumption for this study since historical data was used. While this is a limitation of the study it can be assumed that the HVAC run times for the buildings are similar due to building size, location, number of building occupants, and centralized programming and HVAC scheduling performed from district headquarters.

## Data analysis

*Electrical usage data*

The electrical consumption, shown in adjusted kWh, before and after the energy efficiency charrette at PHS (Figure 1).

The year after the PHS charrette does exhibit electricity consumption savings (Figure 1) and when compared to the year before the charrette, eight of 12 months have a lower adjusted kWh. However, the data two years after the charrette shows consumption decreases. Every month except April, August, September and October of 2009 has lower adjusted kWh values than prior to the charrette.

The electrical consumption, shown in adjusted kWh, before and after the active awareness campaign, designated by the caption "new leaders", at RMHS (Figure 2). For the winter periods following the implementation of the active awareness campaign there is a noticeable drop in adjusted kWh usage.

When comparing pre-treatment to post-treatment electrical consumption, both schools show lower electrical energy consumption. For example, the highest monthly adjusted kWh total at PHS pre-charrette was 248,191 kWh (Figure 1). The highest total

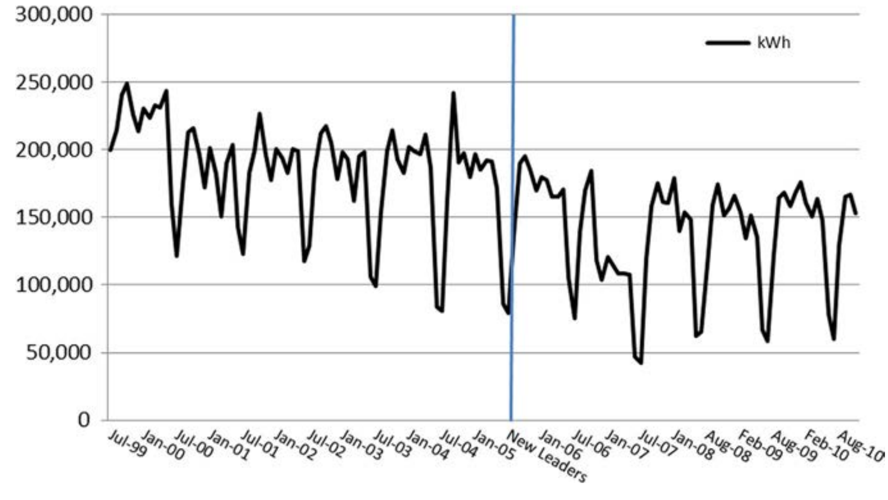


**Figure 2.**
RMHS adjusted kWh consumption before and after active awareness campaign, fiscal years 2000-2010

post-charrette was 203,858 kWh (Figure 2), just over a 20 percent difference. The findings were similar at RMHS. Before the active awareness campaign, the highest recorded monthly kWh total was 248,828, whereas after conservation efforts began the (highest total recorded was 189,920 kWh (Figure 2)).

The data for multiple years are shown in a comparative overlay format (Figure 3). The year after the PHS charrette does exhibit electricity consumption savings. The data is shown for a 12 month period prior/post charette which took place in October of 2007. Compared to the year before the charrette, eight of twelve months have a lower adjusted kWh. However, the data two years after the charrette shows consumption decreases. Every month except April, August, September and October of 2009 has lower adjusted kWh values than the same months prior to the charette.

Since no changes impacting electrical consumption during the study period occurred at the school and weather variations are controlled for, this may suggest a charrette impact beginning approximately eight months after the charrette and lasting for approximately 17 months (June 2008-August 2009).

Compared to PHS, a more pronounced decrease in kWh consumption at RMHS was experienced in the third year (2008) of the active awareness campaign efforts (Figure 4). The RMHS active awareness campaign started in July of 2005 (FY2005) and the data in this figure is presented with the fiscal and academic years being the same; both start in July and end the following June. Every month except August/October 2005 and January/April 2006, both periods are in FY 2005, had lower kWh consumption than the previous year. The data for the second year (FY2007) after the awareness campaign saw much higher kWh consumption compared to the data for fiscal year after the

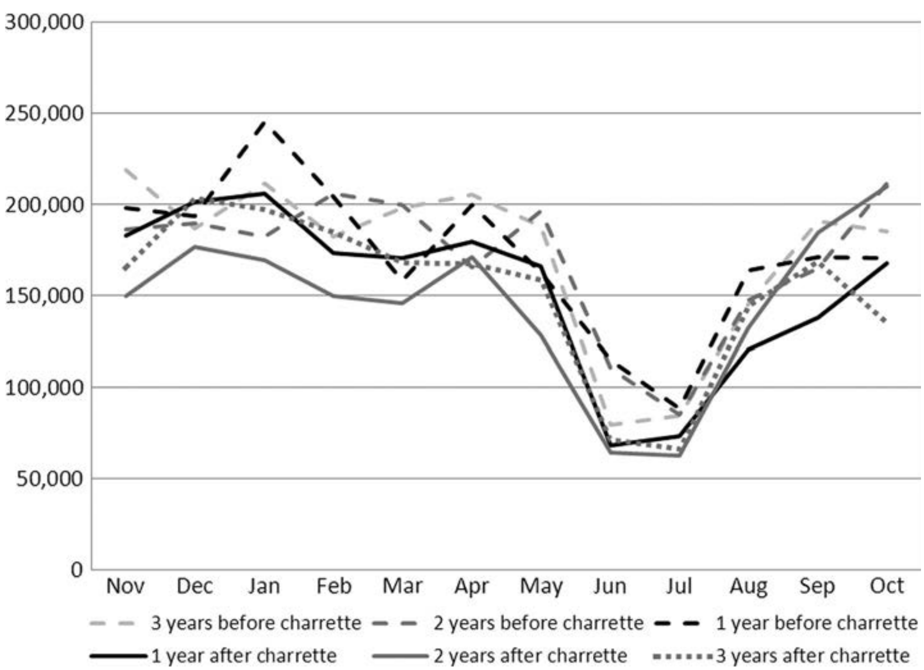


**Figure 3.**
PHS adjusted kWh consumption overlay by year for 12 month period prior to charrette of October 2007

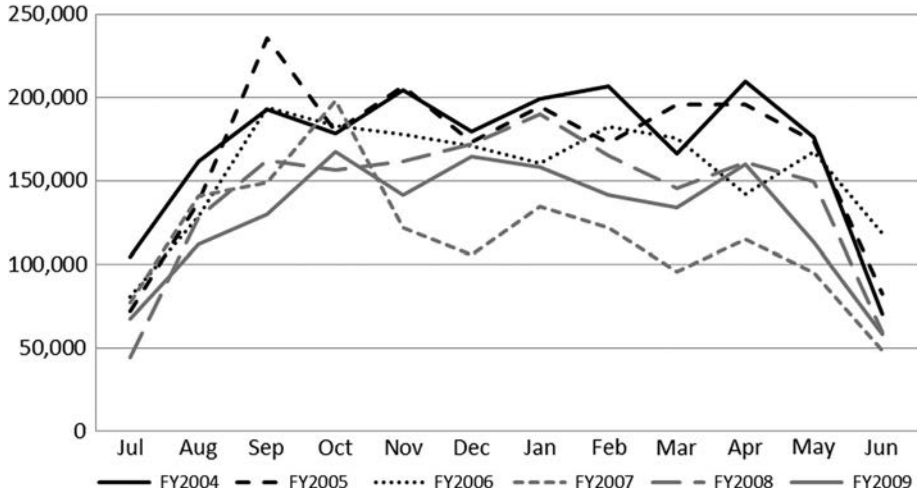


**Figure 4.**
RMHS adjusted kWh consumption by fiscal/academic year

campaign (FY2006). This suggests that the awareness campaign had a more immediate effect than the energy efficiency charrette at PHS.

The change in month by month use data for PHS (Table II) shows larger energy use decreases were seen in 2008 with ensuing increases in the following years.

The change in month by month use data for RMHS (Table III) shows larger average decreases occurred during 2004-2007, with increases and smaller decreases in 2009 and 2010.

This change in use data shows that both the awareness campaign and the charrette had short-term impacts for the two years following the respective events. Unfortunately, these impacts had the tendency to wear off over time.

*Interview data*

Five interviews were conducted with staff at PHS and the initial coding was done using the technique of template analysis outlined by the University of Huddersfield (2007). The initial coding was based on the a priori themes discussed during the charrette:

| Month | 2005 (%) | 2006 (%) | 2007 (%) | 2008 (%) | 2009 (%) | 2010 (%) |
|---|---|---|---|---|---|---|
| January | – | −3 | 29 | 6 | −16 | 11 |
| February | – | −3 | 12 | −29 | −27 | 9 |
| March | – | 10 | −23 | −16 | −16 | 12 |
| April | – | −17 | 0 | 13 | 0 | 15 |
| May | – | −4 | −1 | −17 | −28 | −7 |
| June | – | −41 | −41 | −58 | −61 | −44 |
| July | – | 7 | −20 | −36 | −8 | 3 |
| August | – | 74 | 93 | 36 | 81 | 130 |
| September | – | 13 | 16 | −16 | 53 | 27 |
| October | – | 11 | 3 | −2 | 52 | −27 |
| November | −3 | 7 | −14 | −12 | −1 | −21 |
| December | −13 | 4 | 2 | −4 | 36 | 0 |
| Average | −8 | 5 | 5 | −11 | 5 | 9 |

**Table II.**
PHS% month to month change in adjusted kWh consumption, November 2005-November 2010

**Table III.**
RMHS% month to month change in adjusted kWh consumption, July 2004-November 2010

| Month | 2004 (%) | 2005 (%) | 2006 (%) | 2007 (%) | 2008 (%) | 2009 (%) | 2010 (%) |
|---|---|---|---|---|---|---|---|
| January | – | −3 | −18 | −16 | 41 | −17 | 15 |
| February | – | −16 | 6 | −33 | 36 | −14 | 19 |
| March | – | 18 | −10 | −45 | 51 | −8 | 12 |
| April | – | −7 | −27 | −19 | 41 | −1 | 4 |
| May | – | −1 | −4 | −43 | 57 | −24 | 38 |
| June | – | 17 | 43 | −59 | 23 | −2 | 41 |
| July | −31 | 12 | −4 | −43 | 53 | −25 | 15 |
| August | −15 | −6 | 9 | −9 | −13 | 2 | 18 |
| September | 22 | −18 | −23 | 9 | −20 | 33 | −4 |
| October | 1 | 2 | 8 | −21 | 7 | 16 | −36 |
| November | 1 | −14 | −31 | 33 | −13 | 11 | 1 |
| December | −4 | −1 | −38 | 63 | −4 | 10 | 0 |
| Average | −4 | −1 | −7 | −15 | 22 | −2 | 10 |

- communication;
- motivation; and
- leadership (Schelly, 2007).

The following sub-themes were also identified under each a priori theme:

- increased or decreased awareness of energy efficiency; and
- changed building practices as a result of charrette and building practice changes that remain a challenge or have yet to be implemented.

Specific details that related to each a priori theme were classified as either "contributors" or "obstacles" to the sub-themes.

*Communication*. The interview data for communication was organized using a matrix to highlight the findings for analysis (Table IV). Increased energy efficiency awareness was identified as resulting from an integrated approach which includes involving student

**Table IV.**
Summary of interview responses regarding communication

| Communication | | |
|---|---|---|
| Energy efficiency awareness | Building practice changes | |
| *Contributors* | | |
| Integrated approach | Weekend building use | Changes based on charrette |
| Environmental club | Custodial practices | |
| New student awareness | | |
| *Obstacles* | | |
| MIS-information | Seeing the building as a "whole" | Changes that remain as challenges or have yet to be implemented |
| Staff turnover | | |
| Different perspectives | | |
| Keeping information "fresh" | | |
| Just show me in my classroom how much energy I use with my computer and my lights' | | |

groups based on typical comments like: “I don’t want to do it from a top down bottom up. I would like to make it integrated where people are buying in”. The environmental club was described as playing an important role increasing general awareness about efficiency issues. This, combined with the general curriculum, provided an effective conduit for information regarding energy efficiency in the school. In addition it appeared that the new students had an increased awareness each fall of environmental issues.

Several obstacles to communication were also identified. Misinformation and staff turnover were issues of most concern. The need for continual education of new staff was identified as a barrier to conservation. In some cases a general lack of understanding of the need to conserve energy by some also played a role hindering efficiency goals. One interviewee stated this, “If I knew what the impact leaving on my lights had on energy consumption, I might be more apt to turn them off”. The manner in which energy consumption was communicated during the awareness process suggested more transparency would have helped user understanding of the issues. The information provided typically was given in kWh consumption with no reference point for what kWh’s were or what they explicitly mean. This communication would have helped increase the awareness of the potential changes on behavior usage and may have impacted the results in a positive manner.

One of the building practice changes after the charrette was the curtailment of building use in off-school hours. The head custodian described weekend building use as a “free for all” and “24 hour fitness”. The other practice that has changed is the custodial practice of turning on all the lights in the building and leaving them on until the room is cleaned. Once this was identified as an ineffective energy efficiency strategy, that practice was stopped. The main obstacle in changing building practices is incrementalism; the building needs to be viewed as a whole system, not incremental parts.

*Motivation*. The interview data for energy efficiency motivation identified missing an energy star rating in 2009 as a motivator for increasing energy efficiency (Table V). One respondent was both disappointed that the rating was not achieved and excited for another try next year. Another respondent stated that the effects of this excitement seemed to wear off over time or people did not even know about it. The competition between PHS and RMHS was discussed as a motivator however; this spirit also appeared to wane over time.

Most respondents were optimistic about a general movement to establish norms at the school after the charrette. There were two viewpoints; the green culture was

| | Motivation | |
|---|---|---|
| Energy efficiency awareness | Building practice changes | |
| *Contributors* | | |
| Energy star rating | Changed habit | Changes based on charrette |
| Competitive spirit with RMHS | Collaboration and support of co-workers | |
| Establishment of norms | | |
| *Obstacles* | | |
| No change in habits | State of existing building | Changes that remain or have yet to be implemented |
| Lack of ownership | Money | |
| Not tied to personal finances | Safety | |
| | IT policy | |

**Table V.** Summary of interview responses regarding motivation moving into the schools or the schools were driving this change. Several specific changes were mentioned as evidence of a more conservation oriented culture at school, including fewer cars on campus in the last two to three years and a "general sense of awareness in the school".

The dominant building practice change was turning off the lights when leaving a room. Several administrative respondents indicated they now walk the halls to turn off lights. Teamwork also played a key role in implementing building changes. One respondent made a recommendation to label and break up large lighting circuits to the PSD electrical department. In response "they looked into it and said yeah we can do it, it shouldn't cost a lot of money; we're willing to help". The practice of reducing what lights were turned on and clearly labeling switches was implemented.

A variety of obstacles were described as preventing people from becoming or remaining motivated to conserve energy. The respondents stated that some people leave on lights, unused equipment or appliances, usually out of habit. In other cases people resisted energy conservation because they were not rewarded personally or monetarily. Those individuals who do not view energy use personally and do not believe in global warming were resistant to participating in efforts to increase energy efficiency awareness.

Unfortunately obstacles to motivate building change remain. The lights in the small gym are older style ballast and take several minutes to warm up; they are left on for convenience. Two respondents stated that they did not feel the district was looking long-term enough in regard to energy savings upgrades and paybacks. They also indicated time passage lessened the impact of the charrette; a de-motivator. Student safety was also mentioned as a de-motivator after automatic outdoor lighting controls left parking lots dark and students returning from events at night felt less safe. A final theme concerns the ability to totally shut power off to computers at night. The policy of the IT department is to leave computers on overnight for updates to software.

*Leadership*. The interview data for energy leadership (Table VI) suggests that empowering key players through collaboration and involvement in the charrette had positive results; specifically for the head custodian. The head custodian played an integral role in driving the efforts to reduce energy use once empowered to act and innovate. Trust and leading by example were also described as important. One respondent stated,

| Leadership | | |
|---|---|---|
| Energy efficiency awareness | Building practice changes | |
| *Contributors* | | |
| Empowering key players | Lighting wiring retrofits | Changes based on charrette |
| Staying persistent and "not letting things go" | | |
| Trusting employees | | |
| Teaching by example | | |
| *Obstacles* | | |
| Putting responsibility on others | Lack of resources | Changes that remain or have yet to be implemented |
| Lack of follow up from upper management | Lunch scheduling | |
| Lack of a "top down" mandate | Lack of economic analysis | |
| More involvement by various school groups | | |

**Table VI.**
Summary of interview responses regarding leadership

"I trust the night lead to make the right decision" in regards to how we clean more efficiently. Another respondent stated, "A lot of it is modeling. Like litter, when I see it I pick it up [. . .] It is the same with the lights". Persistence was also identified as important in order to create processes that were not only more efficient but also were accepted into the school culture.

Length of tenure of key personal was mentioned as a potential obstacle. Both the principal and vice principal were recent hires prior to the charrette and appeared to the respondents to have priorities other than energy awareness. Concerning upper management follow through one respondent stated:

> You made a comment about [upper management] following up. And I haven't seen that. We get the email stuff and I can compare most of it. I don't know what I'm comparing but I can see lower numbers so that matters to me. But if they could explain it more.

This comment reflects both the need for leadership and better communication about energy conservation.

Another issue was the mix of the charrette participants. One respondent stated:

> There were a lot of science folks involved [in the charrette] but not a lot of social studies folks. They [social studies folks] are instrumental in getting things done politically.

It's easy to leave the responsibility to others. One administrator said:

> I haven't come out officially and made announcements to people because the environmental science teacher as one of the environmental club sponsors that's kind of been his deal, so I won't interfere.

The dominant building practice change was the result of one employee who took the time to identify and fix problem lighting circuitry. One respondent stated, "I would say this is one of those unexpected successes [. . .] It was great cause he, an electrician, took the time to first of all want to do it, second of all implement [. . .]" Another recent change increased energy consumption. Food preparation and service is another area of concern. In 2009 PHS split the lunch period into two, 35 minute periods; a 20 minute increase in time to operate equipment. Making food and keeping it warm twice a day contributes to higher energy consumption. This impacts the cleaning time frame and uses electricity at peak rates.

## Conclusions

The ability to influence and change building occupant behaviors is an important part of reducing energy consumption. Schools across the country have been able to reduce energy consumption by 10-25 percent through behavioral efforts (Alliance to Save Energy, 2010; Schelly *et al.*, 2010). However, in schools the ongoing energy awareness process needs to be ongoing as institutional memories of the students are transient in nature. The charrette impact illustrates a decrease in electrical consumption followed by a gradual return to higher consumption. This same pattern was found in RMHS following a decline in the intensity of their efforts to encourage conservation behaviors. The behavioral awareness efforts at both RMHS and PHS took time to have an impact on energy use. It appears that a consumption focused effort, like an energy conservation charrette, can have the same kind of impact as a more organically developed effort, like the efforts that developed at RMHS over a few years.

The results of this study highlight the importance of communication, motivation, and leadership at both administrative and staff levels. When changes in key personal happen there needs to be a clear process to ensure that new hires are aware of the commitment to energy use awareness and how important it is to the school district from both an environmental and cost perspective. In order to keep the building occupants' awareness at a high level it is recommended that a charrette be scheduled every year as part of a continuous improvement process.

In this high school, successful energy conservation efforts required one or more energy champions, a top-down mandate, and support from the entire organization. This finding is consistent with the study of energy conservation at RMHS (Schelly *et al.*, 2010). In this study, it appears that the head custodian was the energy champion. He was involved and consulted throughout the process and felt empowered. The administration supported him with resources making his contribution more meaningful. Future success requires even more inclusion in energy conservation efforts. The inclusion of the appropriate stakeholders in the charrette process is important to ensure a successful outcome (Lindsey *et al.*, 2009). At this high school, a future charrette should include a wider variety of teachers in order to have the greatest impact.

Coordination and communication between the facilities and educational arms of a district are also required for successful energy conservation. The interviews indicate that both groups felt that increased communication and administrative support was needed to achieve mutually beneficial outcomes. While facilities staff send out electronic energy reports, the respondents were not clear what to do with that information, and thus were not shared in ways that could have increased conservation efforts. The IT requirements for updating computers prevented a complete shutdown of equipment during the late evening and night. In cases like this the ability to innovate and create new strategies is critical to ensure goal attainment and continual success. This type of cooperation requires support across departments and from the highest levels of administration.

On suggestion to facilitate increased cooperation would be the use of charrettes periodically district wide. This would help share ideas, knowledge, and information relating to energy efficiency at all levels of management. Incremental energy savings from standardized weekend, and summer building use and IT guidelines may be realized from this process. The implementation of a district wide web-based data clearinghouse might facilitate easier, more effective information exchange.

There are several areas where additional research is needed. What could be done to increase the impact time of a charrette or awareness campaign; could these programs be adopted district wide at all grade levels; how could energy awareness be institutionalized so periodic charretts are net necessary? The energy efficiency charrette discussed a wide range of energy sources and sustainability issues in general. Other consumption items could also be discussed in this format: natural gas and water consumption, recycling, food composting, gardening, and tree planting.

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