Common and Common Sense Energy Reduction Methods

Kevin Vidmar

ABSTRACT

Reducing energy use and its resulting carbon footprint is something that all organizations are likely to pursue. Sometimes it is because major retailers, like Wal-Mart, are annually requesting specifics from suppliers and vendors on their energy and carbon footprint reduction programs. Sometimes it is because organizations want a "greener" image, and energy reduction is one good way to show this. But very often, it comes down to simply improving the bottom line.

No matter what the reason, achieving large energy and carbon footprint reductions for your organization can be easy and very cost effective—if you just understand energy use and how to methodically approach energy reduction.

This article will provide you with some common and common sense (two different things) considerations for saving energy and reducing your carbon footprint. We will utilize real world examples, so you will learn not only what has worked for similar organizations but also how and why it worked.

INTRODUCTION

Whether you love or hate Wal-Mart is not something we will debate or discuss here. What we will discuss briefly is the impact that this company and others like it are having within their supply chains with regard to energy and greenhouse gas reductions.

As a result of the actions of such companies, more and more other companies, even smaller ones, are being "formally" faced with the need for energy and greenhouse gas reduction. While everyone should be doing what they reasonably can from a competitive point of view,

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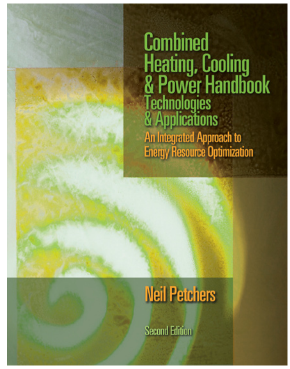

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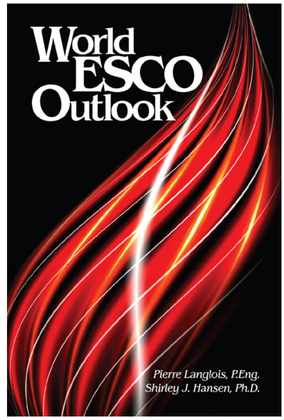

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the Wal-Mart-type annual surveys are taking this to the next level, and quicker than ever before. As more people look to formulate a plan for energy reduction, they look to see what has been done by others, as well as what has worked and what has not worked.

This article will discuss some of the more common general methodologies for energy reduction and compare and contrast these with common sense methodologies. Both can certainly reduce energy use and greenhouse gases. In my experience, both should be considered in a well-functioning and efficient energy reduction plan.

Energy—Common and Common Sense

First, let's start with one of my favorite quotes of all time, from the French philosopher Voltaire:

> "Common sense is not all that common."

To use and understand this saying, we need to ask:

- What is common sense in the first place?
- How does it differ from common activities?
- How does this even apply to something like energy or greenhouse gas reduction?

You may think that "common" and "common sense" mean essentially the same thing. I often find that they are seemingly viewed as different at sites. Perhaps a quick look at some dictionary definitions might help explain why I often see these as different:

> common—*of the best known or most frequently used*

> common sense—*sound practical judgment; normal native intelligence.*

For defining common sense, pay special emphasis to the term *practical*. This often means level headed, useful, and efficient; this does not necessarily mean easiest. In fact, given human nature, the most common thing to do is very often the easiest thing to do.

I often see activities performed at sites that are different than what should be done by using practical judgment. Here is but one quick example to show the possible difference:

Common—*Replacing chillers with more energy efficient models, perhaps involving a variable frequency drive control system*

Common Sense—*Reducing cooling loads as much as possible before considering chiller replacement*

While I know that many people and organizations pursue both of the above, the common sense approach is not pursued enough, in my view. Very often there are great savings to be had, with less capital cost, if a more common sense approach is evaluated first, in addition to the common approach.

From a broader energy perspective, common sense is to begin by looking at not using the energy in the first place, since the cheapest kWh (or therm, or whatever energy unit) is the one not used.

Another way I view common sense: What might I do if it were my own money, my own time, my own resources, etc.?

Some Typical Energy Reduction Areas

In the sections that follow, I will provide examples of typical, common energy reduction applications, followed by what I believe common sense would have us do, given our other inputs and understandings. (These are in no particular order.)

Site Metrics—Part 1

Common—To have a quarterly, if not monthly, capture and reporting system for the whole site, or organization energy metrics. Hopefully, this allows for sites or teams to see overall facility trends after the fact.

Common Sense—This might entail placing energy metrics to as low a point in the organization as makes sense. A key to doing this is that metrics must be collected, analyzed, updated, *and used*—or why even go through all this effort? Metrics can be from submeters, or simply the monitoring/measuring of appropriate energy behaviors. Figure 1 shows an example from a site that had at least one energy-related behavioral metric from all departments.

If specified and prepared correctly, departmental metrics will ultimately align with overall site metrics such that improvements at lower levels will end up showing improvement at the site level and beyond.

Site Metrics—Part 2

Common—Similar to that presented earlier, with typical monthly or quarterly metrics, and larger organizations using commercial systems or energy vendor systems to coordinate and track reporting.

Common Sense—Normalized metrics, using weather, production, or a combination. (Yes, under certain circumstances you can actually use both together.) While not the easiest thing to do, it is very often well worth the time and money so as to truly understand the value of your energy reduction efforts. Are the projects showing expected results? One often needs to go beyond the common metrics to be able to define actual project savings. Normalized or more advanced, combined metric systems can often also be used diagnostically.

Consider the example in Figure 2, in which the graph contains the 12-month rolling averages of heating degree days, as well as decatherms (DTH) of natural gas usage for a site. Notice how the lines appear to diverge about September 2008, and then change again even more significantly in the summer of 2009. From this one metric chart, we could tell that something significant changed, especially in the summer of 2009, and we could then identify and quantify the problem. This sort of diagnosis would not typically be possible with "routine" metric systems.

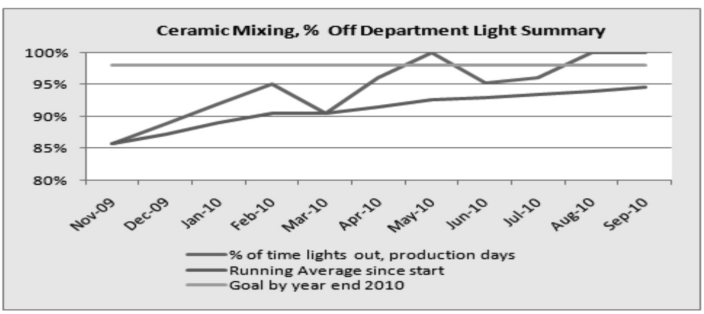

Figure 1

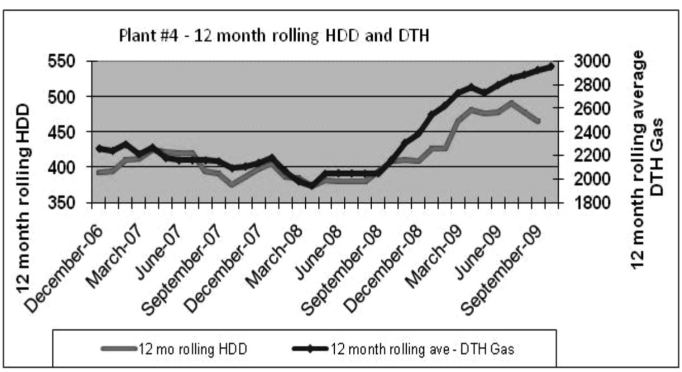

Figure 2

Metrics Visibility

Common—Grouped metric for the whole site, with this one site chart then being posted within each department (changed perhaps monthly, but probably quarterly).

Common Sense—One should make the energy metrics mean something to the employees, who, due to simple human nature, do not typically care as much about areas they cannot control—i.e., the whole site. As an example of making the metric meaningful, at one site a compressed air flow meter was installed and set for the department (totalized flow and instantaneous flow). See the example meter shown in Figure 3.

This meter was read every day, for both actual and instantaneous flow, as well as the total flow for the full day. These values were then logged and visually trended every day to show usage and results. Through this, the site team was able to show the true value of their compressed air reduction efforts. The daily cubic feet values, coupled with appropriate unit costs, were then used to calculate the true savings for the overall site compressed air system. The savings were then allocated back to the employees' department. The point is that these employees could actually control what this meter said, and they took ownership because they had control.

Figure 4 represents another metrics visibility example, where the site team took main electrical meter readings each day and then prepared a running, seven-day average graph each day. This graph was visible to all the site energy team members and, by being updated daily, provided almost instant feedback on progress.

This simple, seven-day rolling average kWh/day graph showed just how fast employees could and would make positive energy changes if they had immediate feedback and had control/ownership.

Presentation of Energy costs

Common—Sites will know their costs per kWh and costs per MMBtu of gas, oil, or propane. More advanced sites might even know the further breakdown of costs. For example, a site might know that kWh usage costs $0.10 and that demand costs roughly another $0.05, for a total blended cost of about $0.15/kWh. Usually only a limited number of people know these costs.

Common Sense—Many people, if not all, will know how much each utility costs and how these costs actually apply to their areas. This seems like common sense, because when you control the small details (uses), the

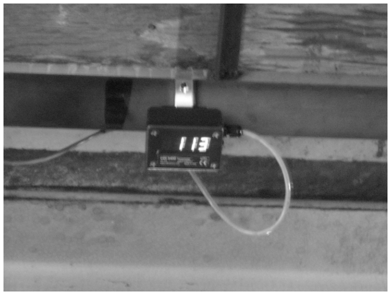

Figure 3

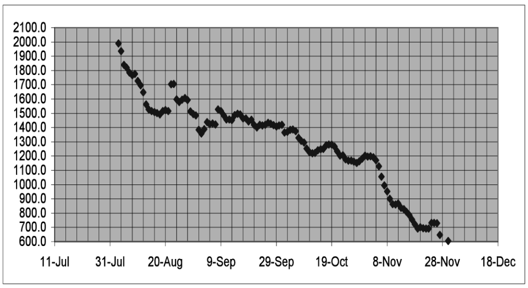

Figure 4

larger results generally take care of themselves. Example unit costs that might make sense include:

- Cost per horsepower per hour for typical motor conditions
- Cost per 1000 cubic feet (KCF) of air. This value should represent the true savings the site would obtain, given the compressed air system's actual performance, as opposed to the typical quick calculation of annual total compressed air electrical cost divided by annual CF air generation.
- Cost of all lights in an area per hour, or per fixture type if appropriate
- Averaged cost to heat each KCF of air, given your actual site and weather conditions
- Averaged cost to cool each KCF of air, given your actual site and weather conditions

With these unit costs, site teams can, on their own, closely approximate costs and savings and then make the appropriate value and project decisions.

Energy Opportunity Identification

Common—Energy audits are conducted by internal or external experts. This usually involves limited or few site staff.

Common Sense—Involve employees at all levels in all aspects of energy savings and management. Full employee involvement is getting to be the norm within manufacturing as a result of the typical manufacturing improvement/support programs like Kaizen, Lean Manufacturing, Six Sigma, 5 S, and the like. It would make sense to include energy in these programs, as these systems already touch many, if not all, employees within an organization. Adding energy as appropriate is a natural extension, and one that we see works very well. All employees use energy at work and at home, and I find that most all are interested in making positive energy change—when addressed correctly (known costs, control, ownership, metrics, incentives or positive reinforcement, etc.). I find that most all employees enjoy learning for themselves how to fish for energy savings, instead of just being given the fish by others.

Perhaps this is the most common sense suggestion in this article. We know from our own experiences that properly managed employee involvement typically provides greater success than slugging it alone; we know that if people are a part of the solution, buy-in is greatly improved. All employees make conscious or unconscious energy value decisions every day, and yet we often do not use this first line of defense.

Opportunity Evaluation Period

Common—See actual site actions and conditions during the day shifts, and get evaluated data remotely from other shifts.

Common Sense—See what is really occurring at all times, day and night, by actually being there and documenting observations. I call this The Every Principle©, summarized as follows:

- Talk to, and involve, everyone.
- Don't believe everything you hear.
- Evaluate everything, everywhere.
- Evaluate at every time of the day:
  - — First, second, and third shifts; weekends
  - — Any "sleeping" periods.

I have found so many little things by following this principle. Even if individual opportunities are not that large themselves, often when you add them all up, you find significant cost reductions—with no/low implementation costs.

Capital Equipment

Common—Teams review what can be added, changed, retrofitted, or replaced with regard to our existing equipment that will make this large investment work better. Salesmen love to sell, and utilities often support these sorts of investments.

Common Sense—Ensure using your existing equipment to the fullest before looking to change it further. This might mean critically evaluating present equipment for function and control. While this often involves cost, most often payback from this effort is very strong. But perhaps just as often, this could simply mean using the already existing capability of equipment and its controls. For example, I see many sites that do not even know all the advanced algorithms of their building management system (BMS). As a result, few of the advanced controls are used. On the plus side, some utilities are now recognizing this, as retro-commissioning is increasingly being discussed and incented.

Energy Savings Review Process

Common—Look at generation efficiency and equipment changes. This is similar to the item above, where we often look to make the larger process or system changes first before considering the full energy use side of the equation.

Common Sense—Evaluate energy use first, so as to reduce use to the extent practical, then do the same with distribution and, finally, (in this order) generation efficiency. A real example from a residence that I worked with can, in concept, work anywhere—house, factory, retail, etc. I like using a particular house example, as it is something that we can all likely relate to in some degree. In this example, the heating need for one air exchange per hour for this house (with its present windows, insulation, and use patterns) would be about 435 therms of natural gas per year. But let's look at the losses at all levels.

First, there is loss from allowing excess air to enter the house. We found a great many problem areas between the conditioned space and the outside, which resulted in an excess 30% air infiltration. Figure 5 shows a picture of the house's pipe wall penetration. (A factory pipe wall penetration is pictured in Figure 6, showing that this is common in either environment.)

Next, working backward, there are distribution losses for the hot air, such as through leaky ductwork, as shown in Figure 7.

Finally, there are the typical gas furnace combustion efficiency losses, which are likely about 20%.

Total system losses, looking from use (bottom), up through excess infiltration, through distribution, to generation show that you need 814 therms of natural gas usage upfront in order to provide your required 435 therms to the spaces. From your actual needed amount, final use is an increase of 87%, as summarized in Figure 8.

Many sites would first look to change the heating plant, so let's run the same numbers, now installing a condensing furnace with only 6% losses (~ $2500, without tax or other credits/incentives). See Figure 9.

So, we would save over $200/yr by spending $2500, which is a 12.5-

Figure 5. Air conditioner condenser pipe wall penetration, which has been corrected with simple expanding foam and tape.

Figure 6. Hole in wall from former pipe wall penetration—never closed off or sealed.

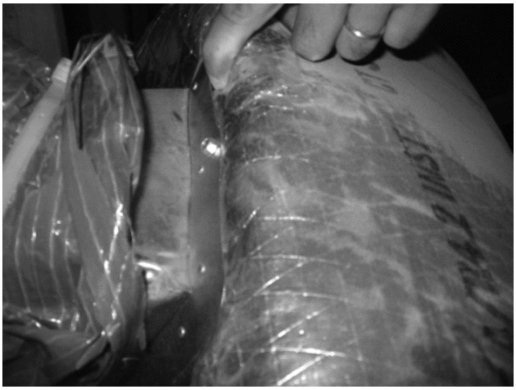

Figure 7. Heated or cold air blasting out of poorly installed ductwork.

year simple payback. Incentives and tax credits could reduce this by half, so it is still over a 6-year simple payback. Therm usage drops by 11.7%.

Now, let's see what happens if one could remove all the excess infiltration (tighten the envelope, "cash for caulkers," etc.) and reduce to 5% the distribution losses. See Figure 10.

Overall therm usage and cost has dropped by 37.5%, with savings of $658/yr. The savings is much greater than if we changed the furnace, and is likely achievable with much less cost than a complete furnace change.

While values for the above table at your home, office, commercial, retail, or manufacturing site might all be different, the overall point is still solid. Both common sense and dollars and cents state that one should at least view energy usage from the inside (use) to the outside. This will ensure maximizing energy savings throughout the entire energy use system.

Furnace Summary, at $2/therm		
Energy needed at front end	877.0	Therms/yr
Generation loss	20%	
Amount needed to distribute	730.8	Therms/yr
losses in distribution - within your house	20%	
Amount actually provided to end use	609.0	Therms/yr
Loss at use point - excess infiltration	40%	
Actual use of energy - needed at end point	**435.0**	**Therms/yr**
Cost for actual needed energy	$ 870	
Cost for base case - per year, actual used gas	$ 1,754	
Extra Cost - due to all three "Losses"	$ 884	

Figure 8

Furnace Summary, at $2/therm, installing condensing furnace		
Energy needed at front end	774.6	Therms/yr
Generation loss	6%	
Amount needed to distribute	730.8	Therms/yr
losses in distribution - within your house	20%	
Amount actually provided to end use	609.0	Therms/yr
Loss at use point - excess infiltration	40%	
Actual use of energy - needed at end point	435.0	Therms/yr
Cost for this case - per year	$ 1,549	
Savings from Base Case	$ 205	
Savings from Base Case, therms	102	
Savings from Base Case, overall %	11.7%	

Figure 9

Furnace Summary, at $2/therm, fix excess infiltration and 75% distribution losses		
Energy needed at front end	548.1	Therms/yr
Generation loss	20%	
Amount needed to distribute	456.8	Therms/yr
losses in distribution - within your house	5%	
Amount actually provided to end use	435.0	Therms/yr
Loss at use point - excess infiltration	0%	
Actual use of energy - needed at end point	435.0	Therms/yr
Cost for this case - per year	$ 1,096	
Savings from Base Case	$ 658	
Savings from Base Case, therms	329	
Savings from Base Case, overall %	37.5%	

Figure 10

Controlling Air flow

Common—VFDs on air handling fans so as to take advantage of the fan laws and save on fan motor energy.

Common Sense—Do the above, but also control outgoing (exhaust) air flow, as whatever you don't extract, you do not have to make up in volume or with changed comfort conditions (heating or cooling). This is a way to reduce overall air flow demand in the first place. One might control exhausts with integrated process control systems or VFDs. Again, the cheapest kWh is the one not used.

SUMMARY

Energy reduction can be achieved through a wide variety of methodologies. Some methods and opportunities are more *common* than others, performed typically no matter what the organization's size or objectives.

However, there are additional, *common sense* approaches that should also be considered. We have tried to show here that sometimes common sense approaches are different, and perhaps a bit harder to achieve. However, applying additional common sense approaches to energy reduction also makes great dollars and cents. We have never seen a case where the additional resources for pursuing common sense initiatives (in addition to the common) did not make strong financial sense when approached systematically.

ABOUT THE AUTHOR

Kevin Vidmar is the Vice President of Energy Services for Loureiro Engineering Associates, a full service environmental, remediation, health, safety, energy, building systems, design, installation, and construction firm with offices in Plainville, CT; Merrimack, NH; and Wakefield, RI. Mr. Vidmar has 26 years of industrial experience and has worked with well over 200 different worldwide manufacturing sites on their energy reduction opportunities, including efforts such as behavioral energy change and energy reduction through Six Sigma and Kaizen programs, as well as the more typical conservation and efficiency changes. He has a B.S. from Miami University, and an M.S. from Vanderbilt University in environmental and water resource engineering. He is a Certified Energy Manager, a Certified Energy Auditor, and a Certified Carbon Reduction Manager.

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