

Driver for Energy Savings: Carrot or Stick?

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In the past decade, significant strides have been made in realizing energy savings in data centers. The question is whether these strides are the product of the “carrot or the stick.” Further, is it better to use the “carrot” or the “stick” within your data center to achieve your energy-efficiency improvements and goals?

It is important to begin by looking at the history behind and drivers for more efficient data centers. The governance of efficiency improvements in data centers is not a simple one. Not all methods of governance are created equal, nor will they produce the desired results and/or change in human behavior. Data centers are facilities driven by complicated behavioral motives that often run in opposition to energy improvements.

Many governance approaches to saving energy in data centers exist; some are better than others, depending on the type of data center business model. Roughly, they can all be grouped into the following categories, each of which will be expanded upon in this column:

- Awareness programs (TC 9.9 & The Green Grid);
- Economic drivers and financial incentive programs;
- Corporate PR or recognition programs;
- Technology improvement programs; and
- Legislative, regulatory, codes & standards programs.

This column will examine the history of data center energy-efficiency governance and whether the “carrot or the stick” is driving the right behavior and subsequent energy improvements.

Background

The gasoline shortages in the early 1970s have generally been credited as being the original “driver” toward energy efficiency. This was followed by increasing prices and an economic motive for energy conservation. Of course, this was all happening before the first PC or first server was invented.

A second significant global driver was the realization that CO₂ levels in the atmosphere were correlated with

a global warming trend. International efforts to control greenhouse gas emissions started with the United Nations Framework Convention on Climate Change in 1992 and continued with the Kyoto Protocol in 1997.

By this time, PCs were a part of most households, and the Internet, along with data centers, had started to grow extremely rapidly. Data center experts, concerned about the increased aggregate energy use of data centers, started meeting in the late 1990s, and many of these players were instrumental in starting ASHRAE’s TG9.HDEC, High Density Electronic Equipment, in 2002, which ultimately became TC 9.9, Mission Critical Facilities, Data Centers, Technology Spaces and Electronic Equipment, in 2004.

By the beginning of the millennium, the trend toward more efficient data centers was clearly underway.

Data Center Trade-Offs

Energy savings in a data center does not come naturally. Many objectives and behavioral dynamics compete with energy objectives. Some of those key challenges can be summarized as follows:

- Rapidly changing technology (challenges to regulating due to a mismatch in life cycles; months or single years for data center technology changes vs. decades for codes and standards).
- The “mission” in mission critical facilities results in a lot of costly provisioning of redundant components, equipment, infrastructure pathways, controls strategies,

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etc., to ensure the facility is resilient to almost all forms of failures/outages.

- Reliable operations are paramount (failures are not an option, which leads to behavior-driven actions to avoid any forms of escalations and eliminate all unknowns).

An example helps clarify the challenges associated with driving energy efficiency in data centers. Imagine your role is the operations manager of a data center and the following typical scenario occurs. Temperatures are monitored 24/7/365 and are alarmed with escalations to your boss, your boss's boss, and so on. At 3 a.m. Saturday morning on a holiday, one CRAH/CRAC unit fails and the lag unit doesn't start, resulting in a high temperature that gets alarmed; the escalations begin. Questions ensue from your management on how this could happen and how to prevent it from happening again.

This scenario plays out all the time in data centers everywhere and drives behavioral approaches to HVAC operations that are not necessarily in line with energy savings.

Imagine a similar scenario in which the chillers failed to restart after the switchover from economizer mode. Another would be the freezing of a cooling tower used in economizer mode for a water-cooled chiller plant. The human response is to disable the economizer operation to avoid future escalations and the responsible individual(s) potentially having to find another job.

This is the reality of data center operations, and this reality must be taken into account when determining what form of governance to select to drive energy savings within a given data center company and facility.

Awareness Programs

Awareness programs have included, but are not limited to, The Green Grid's publications, The EPA's Report to Congress, and ASHRAE TC 9.9's publications.

The formation of The Green Grid in 2007 brought an era of awareness of energy efficiency in data centers through the development of simple metrics. It created and published the power usage effectiveness (PUE™) metric, as discussed in "Data Center Energy Metric" in the January 2013 *ASHRAE Journal*. Today, the PUE is perhaps the most widely recognized energy-efficiency metric for comparing the energy efficiency of data centers worldwide.

In an EPA report to Congress in 2007 (PL 109-431), PUE had already gained common acceptance, and examination of a sufficient number of data centers indicated a downward trend in PUE (from 1.95 in the 2003 sample to 1.63 in the 2005 sample).

By this time, drivers were certainly in place to encourage increased energy efficiency through awareness programs. An update to this EPA report is due by the end of this year and it will be interesting to see how the PUE trend continues.

ASHRAE TC 9.9 has been instrumental in disseminating and publishing information that can be used to implement improved data center energy efficiency. One enabler of increased energy efficiency, the relaxation of temperature and humidity environmental conditions, has been published in TC 9.9's *Thermal Guidelines for Data Processing Environments*, currently in its 3rd edition (ASHRAE 2012), with a 4th edition scheduled for publication by the end of 2015. Two TC 9.9 books were specifically written with energy efficiency in mind. These are *Best Practices for Datacom Facility Energy Efficiency* (2nd Edition, 2009) and *Green Tips for Data Centers* (2010). Also, the primary metric used to assess data center infrastructure efficiency is described in detail in the book *PUE: A Comprehensive Examination of the Metric* (ASHRAE and The Green Grid, 2013).

A book on measuring energy consumption in datacom facilities, *Real-Time Energy Consumption Measurements in Data Centers*, was published by ASHRAE in 2010. Finally, a publication that examines metrics for a subset of information technology equipment (ITE), computers used for storage, has just been published: *Server Efficiency: Metrics for Computer Servers and Storage* (ASHRAE 2015).

Awareness programs are extremely agile and can more readily keep pace with the rapid changes in the data center industry. Typically these programs spur energy-efficiency efforts as a function of their broad reach and acceptance and, therefore, set the stage for either the "carrot or the stick" to be implemented on a company-by-company basis.

Legislative, Regulatory, Codes & Standards Programs

The primary legislative driver for data centers in the U.S., as with most buildings, is the International Code Council (ICC) codes. The International Energy

Conservation Code (IECC) is the version that has its roots developed from and references to ASHRAE Standard 90.1. These codes are adopted by the states. The first edition of ASHRAE Standard 90.1 (Standard 90-1975, *Energy Conservation in New Building Design*) was published 40 years ago. Today, Standard 90.1 undergoes continuous updates, with major new published editions occurring on a three-year cycle. Standard 90.1 excluded “process loads” (which includes data centers) until Standard 90.1-2010 was published. Prior to then, the building shell and office areas were covered under Standard 90.1, but the cooling process for the computer equipment

was considered a process load and, thus, exempt from the main provisions of the standard.

With the inclusion of data centers under the Standard 90.1 umbrella, certain provisions of the standard, such as the requirement for economizers for data center cooling, are now included in the energy code as requirements under the prescriptive path.

By using the stick, not the carrot, these programs get results through mandatory and prescriptive force. They typically involve a much longer cycle for development and implementation. As a result, they often run in conflict with a rapidly changing industry like data centers.

Economic Drivers and Financial Incentive Programs

Economic drivers are the most “traditional” driver of energy efficiency, and few energy-efficiency decisions are typically made without at least some analysis of the trade-off between capital and operating costs. Governmental entities (and utilities) with a vested interest in lowering energy consumption often facilitate energy efficiency through financial incentives.

At the federal level, this has typically taken the form of a federal tax credit. At the state level, incentive programs have been organized that include both prescriptive incentives for equipment with efficiency levels that exceed target levels (such as the currently adopted energy code), and more custom applications.

The custom applications are most typically used for retrofits of existing facilities. In these cases, the baseline is often the as-is efficiency of the data center, and energy calculations

can be performed to determine the change in energy efficiency from the existing condition. The custom incentive can then be paid based on the difference between the existing and the post-implementation energy use.

Colocation data centers tend to adopt these programs much more than other types of data centers, such as those under the U.S. federal government. In short, certain business models are more highly incentivized to use these programs for data center energy savings.

These programs use the carrot approach. In doing so, they are often successful at gaining momentum and adoption because the “bosses” are the ones signing up for the programs. This in turn changes their behavior and approach if a subsequent failure occurs downstream.

Corporate PR or Recognition Programs

Corporations whose mission includes environmental stewardship have several options they can take to decrease the environmental impact of building and operating buildings, and to obtain public recognition for their efforts.

The U.S. Green Building Council (USGBC) introduced LEED for Data Centers as part of LEED Version 3 in 2009, and many data centers have received LEED ratings through this program. Data center owners and operators can also use the U.S. Department of Energy’s (DOE) Energy Star Program to demonstrate low energy use.

The U.S. Environmental Protection Agency (EPA) Portfolio Manager added the data center building type in 2010. Data centers that score

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in the top 25% in terms of energy efficiency can earn the Energy Star rating. The EPA also has Energy Star ratings for servers, which encourages manufacturers to design efficient IT equipment, as well as operators to buy them to minimize energy consumption.

A major component of President Barack Obama's Climate Action Plan includes the DOE's Better Buildings Challenge, whose goals include reducing data center energy consumption. By joining the program, companies commit to reduce their data center energy use by at least 20% over the next 10 years.

The DOE estimated that if all data centers in the U.S. became 20% more energy efficient, the country's energy consumption as a whole would go down by more than 20 billion kWh by 2020. About 200 organizations have joined the Better Buildings Challenge thus far. According to the DOE, they have already completed upgrades to more than 9,000 facilities.

Like the incentive programs, these programs use the carrot approach with similar adoption and acceptance at the management level.

Technology Improvement Programs

Another enabler of more efficient data centers is an impressive increase in energy-efficient data center cooling products. Data center cooling technology is one of the most rapidly improving technologies in the building environment.

Over the past 15 years, chillers and other air-conditioning equipment have become more efficient. Many companies have come out with products, many with innovative

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economizer cycles (such as indirect adiabatic cooling) that have very low annualized cooling PUEs.

These technologies are being increasingly adopted by industry, especially in new construction. New technologies on the electrical distribution infrastructure have included dc power distribution and “eco-mode” uninterruptible power supplies.

In addition to collaborators such as ASHRAE and The Green Grid, work is underway by industry/university cooperative research center programs (I/UCRC), partly funded by the National Science Foundation. One of these programs (I/UCRC ES2, Energy-Smart

Electronic Systems), is actively looking at technologies to save energy. This is in addition to the work done by corporate research departments.

The acceleration and adoption of these programs are often dependent upon select industry companies (with the right business models and financial capabilities), national labs, or other academic or government entities to “prove” or demonstrate these new technologies.

Still to Come

Looking forward, the efficiency of ITE equipment and the infrastructure that serves this equipment will continue to increase, and ASHRAE TC 9.9 will continue to play a major role as a driver in this shift.

A new development is a new energy standard focused solely on data centers. The intent is to replace the prescriptive-based requirements currently in ASHRAE Standard 90.1-2010 and 2013 editions.

This new proposed standard, ASHRAE Standard 90.4P, *Energy Standard for Data Centers and Telecommunications Buildings*, has undergone one public review as of this writing, with a second public review slated for summer 2015. Standard 90.4P is primarily a performance-based standard. To support a performance-based standard, accurate energy models are needed.

Due to the many customized types of infrastructure equipment found in data centers, ASHRAE TC 9.9 is also, in conjunction with other committees, proposing the development of additional energy modeling research through an ASHRAE Work Statement (WS).

Some of the concepts recommended in the WS, such as a server model that can adjust both airflow and power as a function of inlet air temperature, have already been modeled by the U.S. DOE and incorporated into EnergyPlus in the past year. Other concepts will be added to Energy Modeling Toolkits once this research moves forward.

Final Thoughts

A myriad of drivers in the data center and ITE industry continue to create more efficient data centers, mostly through the use of “carrot” programs. Some programs work better for driving actual energy improvements for certain types of data center business models than others (e.g. incentive for colocation). Combinations of programs have helped to further drive improvements.

The industry is committed to reducing energy consumption, while at the same time retaining the very high level of system reliability that is demanded for these facilities. However, no single program is appropriate for all cases.

To date, the industry energy needle has been moved significantly by the carrots, not the sticks. Awareness, incentive, recognition, and technology advancement programs have made a significant difference in the industry’s focus since the late 1990s.

These programs have enabled agility to the industry’s rapidly changing landscape. They have also enabled the necessary adjustments in the mind-set and the associated work flows to modify human behaviors that have long since worked in opposition to energy savings. ■

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