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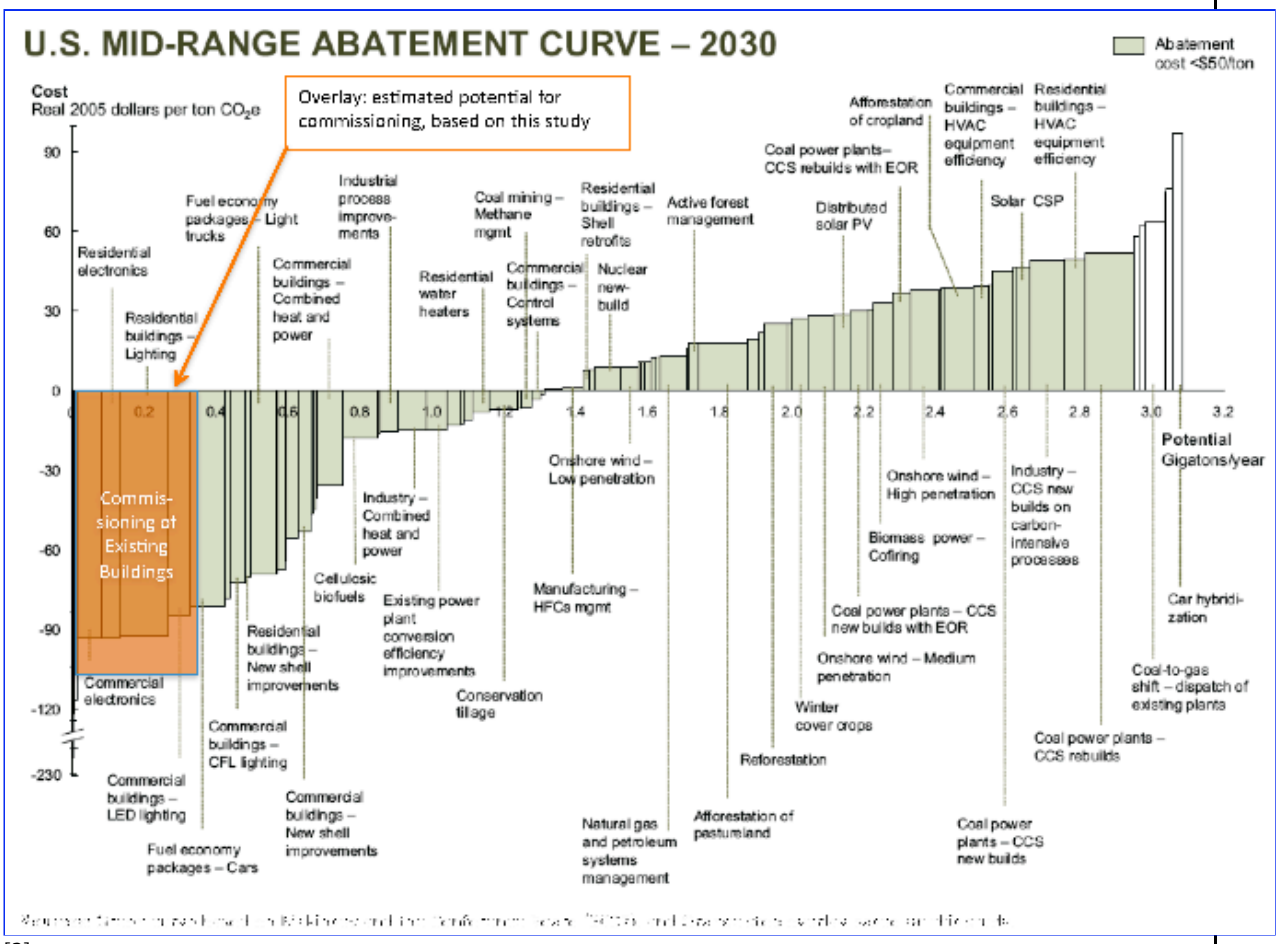
Building Commissioning: The Stealth Energy Efficiency Strategy

Posted By Guest On August 12, 2009 @ 8:34 am In Solutions | 7 Comments

The following post is written Evan Mills [1], a scientist at the Lawrence Berkeley National Laboratory, whom I have known for almost two decades. He recently authored a cost-benefit analysis of energy efficiency measures entitled Building Commissioning: A Golden Opportunity for Reducing Energy Costs and Greenhouse-Gas Emissions [2]. In the figure below, the overlaid orange "step" is derived from the analysis in the new LBNL report and superimposed for reference over McKinsey's 2007 green carbon "abatement curve." The full abatement curve indicates the potential emissions savings potential for a set of measures, ranked by the annualized net cost per ton of emissions reductions (y-axis), i.e., the cost of commissioning minus the value of the resulting energy savings over the measure life. The horizontal width of each step is the potential emissions reduction attributed to each measure.



[3]

One particularly potent form of energy efficiency is an emerging practice known as building commissioning. Although commissioning has earned increased respect in recent years it remains an enigmatic practice whose visibility severely lags its potential. Fortunately, a massive database [2] on commissioning experience in the U.S. provides a potent antidote to those who poo-poo the notion that major greenhouse-gas reductions can be had at negative cost.

The aim of commissioning *new* buildings is to ensure that they deliver, if not exceed, the performance and energy savings promised by their design. When applied to *existing* buildings, commissioning identifies the almost inevitable "drift" from where things should be and puts the building back on course, often making it perform even better than the original designers intended. (Why do we tune up our cars but not our far more complex buildings?) In both contexts, commissioning is a systematic, forensic approach to quality assurance, rather than a technology per se – CSI for efficiency, if you will. Quality

assurance is an essential element of any serious technological endeavor. Energy efficiency is not alone in this regard, and commissioning offers a key solution. (Consider how even more poorly electric power plants would perform if there was no QA in their construction and operation.)

Specific "deficiencies" identified and corrected through the commissioning process include problems like simultaneous heating and cooling (yes, believe it or not, this is common), mis-calibrated or otherwise malfunctioning energy management controls and sensors, defeated efficiency features (e.g., variable speed drives locked at full speed), leaky air-distribution systems, and oversized equipment. Visit our Hall of Shame [4] for more examples. These kinds of problems collectively waste several tens of billions of dollars in energy each year, while compromising occupant comfort, health, and safety. Yes, they should be caught during the original design or corrected by routine operations and maintenance. They rarely are.

Energy-wasting deficiencies are almost always invisible to the casual observer, and unfortunately also to building designers, operators, and owners. Commissioning is not a widgit or "retrofit"; it is an integrated quality-assurance practice. It can reduce the carbon footprint of unremarkable buildings, or ensure the success of ones deliberately designed to be efficient.

Many regard uncertainties about cost and cost-effectiveness as one of the key barriers to the growth of the commissioning industry.

Back in 2004, the U.S. Department of Energy asked my team at Lawrence Berkeley National Lab to build a national database of commissioning experience [5]. Last month, we released a major update [2] —sponsored by the California Energy Commission's Public Interest Energy Research (PIER) program. We gathered data on 643 buildings, representing 99 million square feet of floor space across 26 states. This meta-analysis of real projects has grown to be the world's largest database of commissioning cost-benefit case studies.

The results are compelling. The median normalized cost to deliver commissioning was $\$0.30/ft^2$ for existing buildings and $\$1.16/ft^2$ for new construction (or 0.4% of the overall construction cost). Over 10,000 specific deficiencies were identified across the half of our sample for which data were available. Correcting these problems resulted in 16% median *whole-building* energy savings in existing buildings and 13% in new construction, with payback times of 1.1 years and 4.2 years, respectively. Median benefit-cost ratios of 4.5 and 1.1, and cash-on-cash returns (a common statistic used in the real estate industry) of 91% and 23% were attained. High-tech buildings such as laboratories were particularly cost-effective, and saved higher amounts of energy due to their energy-intensiveness. Projects with a comprehensive approach to commissioning attained nearly twice the overall median level of savings and five-times the savings of the least-thorough projects.

Thanks to energy savings that handily eclipse the cost of the commissioning process, associated reductions in greenhouse gas emissions come at decidedly "negative" cost. Yes, negative costs. In fact, the median cost of conserved carbon is *negative*— -$110 per tonne for existing buildings and -$25/tonne for new construction. This compares quite well with market prices for carbon trading and offsets in the +$10 to +$30/tonne range.

Further enhancing the value proposition of commissioning, its non-energy benefits surpass those of most other energy-management practices. Significant first-cost savings routinely offset at least a portion of commissioning costs—fully in some cases. When accounting for these benefits, the net median commissioning cost was reduced by 49% on average, while in many cases the non-energy benefits fully exceeded the direct value of the energy savings. An example of this, when applied to new construction, is the capital cost savings resulting from "right-sizing" heating and cooling equipment. Commissioning can also avert premature equipment failures, avoid construction-defects litigation, improve worker comfort, mitigate indoor air quality problems, and increase the competence of in-house staff, to name just some of the other non-energy benefits. Indeed, non-energy benefits are often a more important driver in end user's initial motivation to perform commissioning.

Commissioning is arguably the single-most cost-effective strategy for reducing energy, costs, and greenhouse gas emissions in buildings today. Commissioning maximizes the quality and persistence of savings achieved through other energy-saving technologies and practices. The process ensures that building owners get what they pay for when constructing or retrofitting buildings, provides risk-management and "insurance" for policymakers and program managers enabling their initiatives to actually meet targets, and detects and corrects problems that would eventually surface as far more costly maintenance or safety issues. As such, commissioning is more than "just another pretty energy-saving measure." It is a risk-management strategy that should be integral to any systematic effort to

garner and maintain energy savings or emissions reductions.

Applying our median whole-building energy-savings value (certainly far short of best practices) to the U.S. non-residential building stock corresponds to an annual energy-savings potential of $30 billion by the year 2030, which in turn yields greenhouse gas emissions reductions of about 340 megatons of CO_2 each year. How do we capture this potential?

The commissioning field is evolving rapidly. The delivery of services must be scaled up radically. The fledgling existing-buildings commissioning industry has reached a size of about $200 million per year in the United States. Based on a goal of treating each U.S. building every five years, the potential size is about $4 billion per year in commissioning services, or 20-times the current number. To achieve the goal of keeping the U.S. building stock commissioned would require an increase in the workforce from about 1,500 to 25,000 full-time-equivalent workers, a realistic number when viewed in the context of the existing workforce of related trades (which includes far more people).

The energy policy community, however, is behind the curve in utilizing commissioning. Few building codes or utility incentive programs include it, and it is omitted or poorly characterized as a strategy in most energy-efficiency potentials studies. There are important trail-blazers, notably the California Commissioning Collaborative [6], which brings together regulators, utilities, practitioners, and other stakeholders with a collective vision of defining and instituting best practices.

"Commissioning America" in a decade is an ambitious goal, but "do-able" and consistent with this country's aspirations to simultaneously address pressing energy and environmental issues while creating jobs and stimulating economic activity.

Related Post: Energy efficiency is THE most important climate solution [7].
