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A VISION FOR ENERGY PERFORMANCE IN BUILDING DESIGN AND OPERATIONS

A Position Paper on Improving Building Performance

By
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The views expressed in this position paper are those of its author. However, the author would like to acknowledge the contribution of many others as a result of direct and indirect conversations over the months preceding writing this paper. In that time the author has participated in many formal and informal discussions at conferences, meetings and informal gatherings. The major points and conclusions stated in this paper are those of the author, but this does not in any way diminish the important contributions of others from the many discussions in which the author has been involved. The assistance and candor of others in developing the ideas contained in this paper are greatly appreciated.

BACKGROUND

In so far as building energy performance is concerned, the North American building industry has changed very little over the last several years, but in that time society's aspiration for reducing the negative environmental impact of buildings has undergone a nearly revolutionary transition. The result is that the building industry has fallen well behind society's expectations for energy and environmental performance. And the industry continues to employ increasingly outdated technologies, processes and practices that hinder such important improvement.

The scientific community believes that low carbon and environmentally compatible forms of energy that are safe, reliable and plentiful can be developed to become available for buildings by the end of this century. Then, the human contribution to greenhouse gas emissions into the atmosphere from the building sector can be significantly reduced. However, there is also consensus that the current rapid escalation of human generated greenhouse gas emissions must be reduced well before then to ensure the overall level of such emissions in the atmosphere remains below a threshold that would cause much more serious impacts on our planet. Furthermore, it is agreed that the low carbon electric and fuel sources being considered for development will be more costly both in capital investment and in operating costs than current sources of electric and thermal energy now provided for buildings.

For these environmental and economic reasons, it is concluded that the building industry must at this critical time work diligently to transition toward a significantly more efficient and sustainable building stock while these cleaner, and likely more costly, sources of energy are being developed. Beyond helping to reduce the present rate of greenhouse gas emissions, such an effort must be targeted at eliminating the need for investment in any additional high emission sources of energy. Deferring this investment will help reduce the current growth in emissions and also reduce the costs associated with low emission sources when they become available.

To remain relevant as serious players in this transition to a more sustainable future, industry members – manufacturers, designers, contractors, owners and institutions – must consider how effective any action they may take will be to close the widening gap between society's energy performance expectations and the industry's ability to meet them. One should conclude that disruptive rather than evolutionary measures are required to reverse the current trends. Bold thinking and actions are needed. Less ambitious actions may be counterproductive by diverting focus and the limited pool of experienced talent available from the real task the industry now has before it.

THE IMPORTANT ROLE OF ENERGY PERFORMANCE

The social movement toward a more sustainable built environment has a number of manifestations that range all the way from the aesthetics of buildings to indoor environment, to usable life, to convenience and accessibility, to resource utilization and depletion, to pollution and environmental degradation. In the coming months and years, all of these issues must be specifically addressed and the industry's handling of each of them must be vastly improved upon beyond processes and technologies now being applied. However, for reasons noted, energy performance is presently a major world wide shared concern both from the standpoint of resource depletion and also of environmental degradation. This paper is aimed at the energy performance aspect of our building stock, at least in part because over the lifetime of any building the energy consumed has a very significant effect on the aspects of our environment that are of most immediate concern.

EMPHASIZING ENERGY PERFORMANCE

Currently, there is very little emphasis on the energy performance of buildings within the building industry. Designers, contractors, and operators seldom have a good understanding of the energy performance aspects of their work. Furthermore, energy use is generally a relatively small factor in the economics of buildings so there has historically not been a strong emphasis on energy performance by building owners. The result is that today there is a lack of accountability or control in integrating energy performance criteria throughout the building design, construction and operation processes. This lack of accountability and control are major reasons actual monitored building performance varies widely when compared to projected performance, and why owners demand uniquely short payback periods for energy reduction investments. It can be concluded that to raise the focus on building energy performance sufficiently to meet increasing society expectations, steps must be taken to integrate superior building energy performance criteria much more deeply into the building design, construction and operating processes.

ENERGY PERFORMANCE THROUGH ACCOUNTABILITY

Accountability is a key to the success of any strategy aimed at substantially reducing building energy use. Once a stronger emphasis is placed on building performance,

more advanced energy performing technologies will be pulled into the industry and effectively supported. However, due to the fragmented structure and processes involved in the building industry from design to building operations, developing accountability is not a simple matter. To accept accountability, generally requires one also have authority to exert control over the processes involved throughout design, implementation and operation. Designers have only limited control of the construction and startup processes and almost no control of building operations. Contractors and operators typically have even less influence on other elements of a building development project. However, building owners do have control over each of these stages in the design, construction, and operation of buildings. It therefore is correct to conclude that to move the building industry quickly to a more energy efficient future requires the fundamental accountability for energy performance of our building stock to reside with building owners. If this responsibility is properly defined, owners can dictate energy performance criteria to designers, contractors and operators in the same manner that a requirement for leaseable area is defined and becomes a shared concern for all throughout the design/construction/operation cycle.

METRICS FOR MEASURING ENERGY PERFORMANCE

Once it is agreed upon that the building owner is the correct point of accountability for building energy performance, then the key issues are what should be the standards to which each building is held accountable and what metrics should be employed to determine if the appropriate standard is being met. As far into the future as it is now possible to view, building energy needs will be served by utilities with metered energy flows and peaks. Since energy use is the fundamental parameter of concern, performance metrics should be developed around the actual metered energy use of each building. There is further discussion of this topic later in the paper.

Although logic points to utility metered energy use as the best and most efficient metric for evaluating energy performance, it is not difficult to find substantial issues with relying solely on utility metered energy use, especially in the near term. For example, designers argue that while they need to accept responsibility for the designed operating efficiency of many of the building systems, they cannot take responsibility for the operation of these systems, and therefore once a building is turned over that responsibility must be assumed by the owner through the operations staff. Furthermore, designers cannot take responsibility for certain internal loads such as “plug load” beyond developing systems that can handle expected ranges efficiently and working with the owner to develop guidelines for ensuring such equipment meets minimum efficiency standards. Contractors and building operators have similar responsibility concerns.

For the responsibility concerns outlined above, the performance monitoring metrics need to be more granular than are currently provided by utility meters as our industry reorganizes itself to place a strong emphasis on sustainable buildings. It is essential that performance monitoring be integrated into the building systems and startup process

to provide additional information. Design teams need to incorporate adequate measurement metrics into the design of each new building or building retrofit so that it is shown clearly that the systems for which they are responsible perform as expected. Similarly, contractors need to show that the equipment they supply performs as expected, and operators need monitoring to know that they are operating and maintaining the equipment as planned. To do this, a "prescriptive" category of energy performance monitoring can be developed that includes ***heating, cooling, air delivery, lighting and plugload*** energy use expressed in total kWh or BTU (and generally calibrated per unit building area such as kWh/SF) over a variety of accounting periods – primarily monthly and annually. Since total energy use will depend on factors beyond the designers' and contractors' control, a second "performance based" category that includes ***heating operating efficiency, cooling operating efficiency, and air delivery operating efficiency*** expressed as an overall system C.O. P., kW per unit output, or in similar terms must also be monitored. The exact parameters required for any building may vary somewhat depending on the nature of the systems incorporated. The prescriptive and performance based monitoring can be incorporated into the control system employed to operate the system or building, or may be provided with a dedicated system that acquires data through the building or system controls. These basic performance monitoring parameters permit each building or system to confirm at startup up and turnover that the design intent level of performance has been met. Designers, contractors and commissioning agents can from this data each show they have completed their work in accordance with energy performance criteria. From then on, the building owner through her or his operations staff assumes the major burden of responsibility for operating the building systems effectively such that the performance for each of these categories is maintained and thus the building meets its overall performance goal as read by the utility meter(s) each month.

ESTABLISHING ENERGY PERFORMANCE STANDARDS

Having determined that the most straightforward path to a more sustainable building stock is a performance standard that owners of buildings are responsible to meet, the next step is to determine the energy performance standard that each building must meet. Here, there is a successful existing process that provides an excellent basis for building performance standards and that is the EPA Energy Star program for building energy use rating. This is a process wherein buildings are categorized by building type and the standard is then based on a climate compensated standard energy use per unit area of the building. This is a relatively simple and straightforward method that is already employed for the Energy Star rating. While the types of buildings in the existing rating program need to be expanded, it certainly appears the process could easily be extended and applied as a mandatory city, state or national requirement for all buildings. In addition to the need for increasing building types, separate categories should be considered for existing and new buildings, with new buildings requiring more stringent energy performance standards and existing buildings adhering to lower minimum ratings that become more stringent over time. It is suggested that single family

residences employ a standard process in which smaller buildings have larger per square foot energy allowances. This would make it incumbent upon those building large homes to make them much more efficient.

LOOKING AHEAD: INCORPORATING ENERGY PERFORMANCE STANDARDS INTO UTILITY RATE STRUCTURES

An important dialog has begun about whether it is useful to continue to engage utilities as a primary instrument of energy efficiency programs for the built environment. This is a healthy discussion and it needs to be continued since these programs as applied to the built environment have largely been unimaginative, cumbersome and have achieved only limited energy efficiency improvements – certainly well below what is achievable and below what is required for the needed move toward a sustainable built environment. Regardless of how that discussion develops, it is important that utilities and regulators be engaged in any developing building performance standard program. An important step, once an energy performance standards system has been developed and shown to work, is to institutionalize these standards by adjusting utility rates such that marginal cost of energy for each building increases substantially if the building begins operating above the standard's limit in energy use for its size, type and local climate. Such a rate, which has already been test implemented and is called an "excess use rate", provides a strong incentive to building owners over time to maintain their energy use within the standard limits, and it also provides a much improved incentive for investments by the building owner in measures that will reduce energy use to within the building's energy performance standard usage.

RECOMMENDED NEXT STEPS

The window of opportunity for making a significant change in the environmental consequences of the effects of energy use over the last several hundred years is now considered by scientists and energy experts to be relatively narrow. While significant progress in energy efficiency improvements have been made since the original energy crisis era thirty years ago, it is widely understood that it will be necessary to advance energy efficiency far more substantially in the next thirty years. Getting started now on an effective path to that end is essential to becoming successful in that endeavor. The next logical steps that follow a discussion and acceptance of the principle of energy performance standards are recommended as follows:

1. Develop effective climate compensated performance standards for all the building types that constitute the current energy consuming building stock. It is recommended that the Energy Star program be used as basis for this expanded set of standards with the understanding that the Energy Star program is ready to work with industry groups to expand this program to meet this end.
2. Work with cities and states to implement performance standards into enforceable codes and regulations. Annual certification of minimum building performance may be tied to tax rate or other local or state surcharge or could be tied to the

electric rate as noted below. There are a variety of methods that have been considered and discussions with local governments should be initiated to find the most straightforward path. It is not difficult to imagine local laws requiring all existing buildings to meet a certain Energy Star or other accepted performance rating level by a specific date, and any new buildings to meet somewhat more stringent energy performance requirements based on the same metric.

3. Work with utility regulators to begin implementing “excess use” type energy rates wherein the energy unit cost for each building escalates at usage above the performance standard for that building. If such a path proves possible in the near term, it could completely replace the need for additional local laws as noted above. Utilities in some areas may also provide energy performance certification for new buildings and even energy performance monitoring services.

The positions and next steps recommended in this paper are the result of an exhaustive effort to determine the most effective path for incorporating significant improvement in building energy performance quickly. This paper is intended to be circulated widely and the author requests readers to provide comments, criticisms and alternative thoughts so that we as an industry can reach a level of consensus as to how best to move forward and meet the challenge we face over the next several decades. Please address any comments or criticisms to: Tom Hartman (tomh@hartmanco.com)