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ZERO ENERGY COMMERCIAL BUILDINGS CONSORTIUM

ANALYSIS OF COST & NON-COST BARRIERS AND POLICY SOLUTIONS FOR COMMERCIAL BUILDINGS

ZERO ENERGY
COMMERCIAL BUILDINGS CONSORTIUM
CBC

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CBC Steering Committee Members

DISCLAIMER

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LIST OF ACRONYMS

AIA/COTE	American Institute of Architects Committee on the Environment
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASTM	ASTM International
BEPA	Building Energy Performance Assessment (standard)
BIM	Building Information Modeling
CBC	Commercial Buildings Consortium
CBD	Climate benefit district
CHP	Combined Heat and Power
COMNET	Commercial Energy Services Network
DOE	U.S. Department of Energy
DSIRE	Database of State Incentives for Renewables & Efficiency
DSM	Demand-side management
EPA	Environmental Protection Agency
EUI	Energy use intensity
FIRE	Finance, insurance, real estate
GHG	Greenhouse gas or greenhouse gases
HVAC	Heating, Ventilation and Air Conditioning
ICC	International Construction Council
ID	Integrated design
IGCC	International Green Construction Code
M&V	Measurement and verification
NASEO	National Association of State Energy Officials
NBI	New Buildings Institute
NGO	Non-governmental organization
NZECB	Net-zero Energy Commercial Buildings
O&M	Operations & maintenance
POE	Post-occupancy evaluation
PV	Photovoltaic
TIF	Tax-increment finance
WIB	Workforce investment board
zEPI	Zero Energy Performance Index
ZNE	Zero Net Energy

COMMERCIAL BUILDINGS CONSORTIUM OVERVIEW

In the United States, the buildings sector accounts for approximately 40 percent of total energy consumption and roughly 40 percent of greenhouse gas emissions.[1] About half of this is attributable to the commercial sector, and commercial building energy use is growing more rapidly than residential sector energy.[2] Dramatic improvements in the energy performance of commercial buildings can reduce greenhouse gas (GHG) emissions more quickly and more cost-effectively than many other options, while helping reduce the impact of rising and increasingly volatile energy prices. Transforming energy performance in commercial buildings requires a comprehensive and concerted industry effort, sufficient in scale to influence the more than $600 billion per year that the sector spends on new construction, renovation, and energy.[3]

In response to that need, the Commercial Buildings Consortium (CBC), a public-private, broad-based stakeholder group was established to help achieve near-term results with lasting impacts that can transform the commercial buildings sector to long-term net-zero energy goals. The CBC works to capture market feedback on key barriers; identify innovative strategies and successful approaches; and facilitate information and knowledge transfer among stakeholders. Led by a Steering Committee representing prominent national industrial firms, NGO's, and public organizations, the CBC formally launched in late 2009. The National Association of State Energy Officials (NASEO) administers the consortium and serves as its secretariat.

While net-zero energy commercial buildings is the CBC's long-term vision, the CBC has primarily operated under the assumption that viable low-energy or net-zero energy buildings must first aggressively maximize energy efficiency before integrating renewable energy. Consortium members participate through focused working groups, which paid particular attention to identifying recommendations that can be acted on in the near-term. Rather than adopt a former definition for net-zero energy, which is a topic of much debate, the CBC views net-zero energy as a directional goal, which helps to concentrate and push thinking beyond traditional approaches. The CBC recognizes that there are many milestones on the pathway to zero and has focused its technology and policy barrier analysis and recommendations on actions in the next 2 to 5 years which can have lasting impacts.

CBC Report Objectives and Development

In its first year, the CBC was tasked by the U.S. Department of Energy (DOE) to compile and assess information on next-generation technologies, systems, and practices and to identify market potential, barriers, and strategic solutions needed to accelerate their deployment and

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[1] 2010. US Department of Energy, Energy Information Administration. *Annual Energy Outlook 2010 Early Release Overview.* http://www.eia.doe.gov/oiaf/aeo/

[2] 2009. US Department of Energy, Energy Efficiency and Renewable Energy. *Buildings Energy Data Book*. Building Technologies Program. http://buildingsdatabook.eren.doe.gov. Washington, D.C.

[3] Ibid.

widespread use. The intended audience and beneficiaries of these reports are the commercial building industry stakeholders, and any findings and recommendations are aimed for their benefit and use. In instances where a recommendation has an unspecified audience or actor, the audience or actor is intended to refer to industry partners and stakeholders.

To accomplish this task, the CBC organized its volunteer members into 12 topical working groups. The working groups were divided between Technology & Practice and Market & Policy topic areas, corresponding directly to the technologies and the policy reports, which reflect their deliberations. To date, over 400 organizational members have signed up overall. Of those, over 200 groups are registered as active members who participate in the working groups. The remaining members participate as associates to receive regular updates on the CBC's activities.

Figure 1: Zero Energy Commercial Building Consortium Working Groups

Technologies & Practices	Market & Policy
1. Building Envelope	6. Codes and Standards
2. Mechanical Systems, Plumbing, and Controls	7. Integrated Design and Building Delivery
3. Lighting/Daylighting and Controls	8. Benchmarking and Performance Assurance
4. Process, IT, and Miscellaneous Equipment	9. Voluntary Programs
5. Combined Heat and Power (CHP), Multi-Building Systems, and Grid Integration	10. Financing and Valuation
	11. Owner/Tenant Issues
	12. Workforce Development

Source: Commercial Building Consortium

Each working group is chaired by two industry experts. Some groups, such as the Lighting, Daylighting & Controls group and the Benchmarking and Performance Assurance group, further segmented their topic into subgroups and recruited expert volunteers from within the larger groups. Working Group chairs engaged members to provide input through online tools and surveys, conference calls, and webcasts. Over the last year, volunteers from active member organizations participated on over 45 working group calls. Collaboration included sharing resources and information, actively drafting content for the working group reports, and providing comments to outlines and drafts. Each working group developed a report on which the CBC final reports are based. In addition, the CBC drew on existing information sources and literature and evaluated high-performing building projects to identify technologies and barriers.

The results of these efforts are summarized and documented in the following reports:

- *Commercial Building Technologies Inventory*

- *Next Generation Technologies Barriers and Industry Recommendations*
- *Analysis of Cost & Non-Cost Barriers and Policy Solutions*

The CBC recognizes that gaps still remain in the technology inventory and reports to address in subsequent annual updates. The CBC invites its members and other stakeholders to provide comments to these reports. Comments can be submitted to Diana Lin (dlin@naseo.org). Interested parties can also contribute in the upcoming updates by joining as a CBC member.

EXECUTIVE SUMMARY

MARKET AND POLICY BARRIERS AND RECOMMENDATIONS

The following summarizes key barriers and recommendations from seven Commercial Buildings Consortium (CBC) working groups focused on market and policy topics:

- Codes and Standards
- Integrated Design and Building Delivery
- Benchmarking and Performance Assurance
- Voluntary Programs
- Finance and Valuation
- Owners and Tenants
- Workforce Development

Each group's full draft report can be found on the working group pages of the Commercial Buildings Consortium website (www.zeroenergycbc.org). Each report contains substantial additional information on the current state of the art within each area, significantly greater detail on barriers and recommendations and generally more background, discussion and references to support the conclusions drawn. The report summaries are necessarily abbreviated to provide a broad view of critical issues; readers with an interest in a given topic are directed to the full working group reports to better understand the range of discussion and depth of the barriers and recommendations.

Additionally, two technology-focused companion reports by the CBC, a *Commercial Building Technologies Inventory* and *Next Generation Technologies Barriers and Industry Recommendations*, provide further discussion on high-performance, low-energy commercial building technology challenges and potential solutions.

There are several general observations that provide context for the reports, as well as a few cross-cutting issues:

1. While the topic of this report is net-zero energy commercial buildings (NZECBs), the effort to date has focused on how to achieve deep levels of energy efficiency, with very little effort in the working groups focused on integration of renewable energy into the built environment. The view reflected by this action is that high levels of energy efficiency are the first, largest and most important step on the way to net-zero. Therefore, in this report, policy and market actions are more directed to support low or ultra-low design and construction, or deep energy savings for existing buildings.

2. Related to the focus on energy efficiency rather than renewable integration, the majority of recommendations are focused on near-term (2 to 5 years) as opposed to long-term actions.

Net-zero-energy buildings provide the ultimate goal which shapes the critical thinking in the recommendations, but the actions recommended are achievable near-term and have both short-term and far-reaching impacts.

3. There are several instances where multiple working groups focused on aspects of essentially the same recommendation, pointing to the importance of those areas, including:

- Integrated design is more critical to the development of low/zero-energy buildings than is any given technology. Tremendous efficiency opportunities (as demonstrated by best practice) can be accomplished with today's technology.
- Moving beyond design and construction into operations, plug loads, process energy and other "unregulated loads" is a critical step in reducing energy use. This will only increase in importance as buildings become more energy efficient in their enclosures, lighting and mechanical systems.
- There is need for a consistent, long-term metric to measure the performance of buildings and policy. Suggested by several groups is the Zero Energy Performance Index (zEPI), which places the average, normalized energy use intensity of buildings at the turn of the millennium at 100, with zero as a true zero-energy building (as defined today).
- While EPA's Portfolio Manager has achieved significant success as a benchmarking tool, both in the market and by state and local policy makers, there is a need for additional benchmarking elements that provide information to support actions and add new elements to better meet the needs of particular audiences (e.g. financial, monitoring, commissioning).
- More measured performance data is needed at the case-study level, the system level (e.g., lighting vs. plug loads) and to support owner and private financing.
- There needs to be aggressive financial incentives to achieve net-zero-energy building goals. Government purchasing policies that call for net-zero buildings, coupled with a framework for accountability and performance assurance will pave the way. Utilities need greater incentives to support cost-effective investment in DSM towards deep energy efficiency and net-zero goals.

It's clear from the working group reports that a tremendous amount of work has been accomplished in recent years to accelerate the pace of energy efficiency in the buildings marketplace. Still, while there is excellent leadership in all critical areas, progress is uneven nationally, critical issues remain and national leadership is essential in a wide range of related issues to plug in the energy efficiency resource and begin tapping its full benefits. The range of issues covered by the working groups is amazingly broad, yet progress must be made across the board to begin the process of remaking our building stock. Net-zero-energy buildings create a catalyst to stimulate the thinking and actions required, even if near-term needs are more related to establishing key fundamentals that allow the energy efficiency market to progress in a more rapid and sophisticated way.

CODES AND STANDARDS

The move to a zero-energy building stock will likely require a series of major shifts in the structure of codes, both in the presentation of code requirements and in ensuring compliance. It will become increasingly critical that enforcement agencies have adequate capacity, understanding, technology and training. New ways to ensure compliance outside of the traditional plan review and inspection process must be developed.

GAPS AND BARRIERS

Current code processes cover design and construction up to the point an occupancy permit is issued. It is *after* a building is occupied that it uses energy and must perform. That energy use is only partially controlled by design and construction; how the building is operated and the loads created by the occupants' use will be increasingly significant aspects of energy use as we move to zero-energy buildings.

Changes to existing energy codes, which all have a prescriptive foundation, are often described as an improvement of "X" percent over the previous code. This is immediately confusing, even to those involved in code development. Not all energy use is regulated under the code, so it is unclear whether the percentage improvement refers only to regulated energy use or to whole-building energy use. This unregulated energy use is often greater than 20 percent, and sometimes more than 65 percent, of building energy use. It gets more complicated when describing changes that occur over multiple code cycles. Moreover, these percentages are based on an aggregation of different commercial building types over a wide range of climatic conditions, yielding a singular number intended to represent all buildings nationwide.

Codes and standards are prescriptive and do not set criteria for fenestration area or building geometry. Therefore, two buildings of the same type with the same floor area and use can each meet the codes and standards while their predicted annual energy consumption may vary by a factor of two or more.

As Charles Eley notes in the white paper "Rethinking Percent Savings," a paradigm shift is needed in codes and standards development. The current process of identifying a set of prescriptive measures for compliance and then defining a performance analog is not sustainable as we move towards net-zero. What is needed are established energy performance targets for different classes of buildings, normalized for neutral variables such as climate, occupancy and operating hours.

INDUSTRY RECOMMENDATIONS

1. Expand the scope of energy codes to account for energy consumption that is not currently addressed (e.g., all energy use associated with commercial buildings). Current codes and standards do not take into account elevators and escalators (vertical transportation) or plug and process loads. Plug and process loads encompass energy used by equipment not included in the building during construction (such as computers, appliances and refrigeration). To control this expanding use, future codes must include them.

2. Base energy codes on desired outcomes in terms of total annual energy use associated with nonrenewable energy forms. Since their inception, the basis for energy codes and standards has been prescriptive rather than focusing on the end goal of energy use. The solution: a code that establishes a building energy use metric normalized for neutral variables such as occupancy, climate and building type paired with the establishment of an outcome-based goal. Moving to outcome-based code requirements based on the actual consumption of nonrenewable energy will encompass all energy end uses and support innovation in design, controls and operations. This outcome-based goal will encourage innovation and allow energy-efficient technologies to compete on an even playing field.

3. Establish minimum prescriptive provisions to penalize the use of low-performing systems and restrict their use as the baseline system. Currently both lower and higher efficiency building systems are measured against the same benchmarks. This has the effect of setting "a higher performance baseline for projects considering higher performance design and equipment options."[4] To progress toward achievement of net-zero buildings, these poorer performing systems must be penalized by establishing the outcome or performance cutoff at a level that makes it difficult to comply using older technologies.

4. Establish performance targets relative to a fixed benchmark by building type. Improving the understanding of and ability by which energy codes can actually increase efficiency necessitates establishment of a clear, fixed metric with a baseline that allows progress toward a net-zero-energy building stock. In short: setting a goal on the horizon to strive toward. A benchmark normalized energy use index (EUI) can be established based on statistical averages from data sources such as the Commercial Buildings Energy Consumption Survey (CBECS). A top-down process can then be implemented that first establishes an energy performance target and then develops design approaches (by building type) to cost-effectively meet it.

5. With outcome-based codes, develop a wide range of design guides, commentaries and case studies that when followed will result in realization of the desired outcomes. In setting an outcome-based metric, there is a challenge to address the needs of those who may not know how to achieve the goal and need prescriptive guidance. As designers proceed to develop complying designs, and as buildings are occupied and perform, data on "how to get the job

[4] Hewitt, Dave, Mark Frankel and David Cohan. "The Future of Energy Codes." http://newbuildings.org/sites/default/files/Future_of_Codes-ACEEE_Paper.pdf.

done" will become available. This information need not be vetted through a consensus process but simply published as design guides, commentary, case studies and other resources.

6. Existing buildings must be effectively addressed through code improvement goals tied to the desired outcome, but recognizing they need to be treated differently than new construction. Research has shown that retrofitting existing buildings with energy efficient upgrades can result in significant progress toward net-zero energy use. Despite these potential savings and benefits, building owners sometimes forgo equipment and system upgrades because implementing them could trigger the need for additional upgrades to meet code minimum requirements – and possibly increase cost significantly.

7. The statement of established outcomes can support reach codes that provide predictability to the market on where energy codes can progress in subsequent cycles. Reach or stretch programs have historically paved the way for new codes and standards; many of the concepts contained in current standards can be traced back to reach programs. Over time, ideas originally proposed in reach codes often emerge as recognized industry practice. Thus in many ways reach programs have led the charge toward and set the stage for, higher, more ambitious industry goals. Both ICC and ASHRAE have developed "green" codes (e.g., the International Green Construction Code or IGCC and ASHRAE Standard 189.1) with advanced energy performance requirements that can serve to field test new technologies and systems for incorporation into base codes in future cycles.

8. Take into account the impact of software tools and information technologies in changing the manner in which buildings are designed and constructed. Significant progress has been made in information technologies that have translated into the building industry. One such example is BIM. BIM represents one of the most powerful tools for optimizing building performance, allowing the creation of a virtual model building to consider options in size, shape and appearance. These virtual models can readily connect building data to energy software to predict energy performance, daylighting and other key variables, thus providing valuable information on opportunities for increasing energy savings.

9. Develop mechanisms to ensure continued building performance at initial occupancy and beyond that includes how occupants impact building performance. Current energy codes do not contain provisions that allow for requirements or enforcement of such requirements beyond issuance of a certificate of occupancy. Ongoing activities like operations and maintenance, commissioning (including re-commissioning, retro-commissioning and ongoing commissioning) and occupant education and training must be mandated and enforceable in the future to assure design intent, as embodied in the stated outcome objectives, is met over the life of the building.

INTEGRATED DESIGN AND BUILDING DELIVERY

Integrated Design (ID) is a critically important approach to achieving cost-effective net-zero energy buildings. Integrated design and integrated project delivery apply to all aspects of project development, from design and construction through occupancy. Given that a net-zero-energy building will rely on the functional interdependency of its major passive and active elements, integrated design and effective building delivery are critically important.

In the development of the CBC *Next Generation Technologies Barriers and Industry Recommendations* report, the CBC technology-focused working groups unanimously noted the imperative of an integrated design process to ensure optimal system interactivity and interoperability and achieve maximum whole-building performance. This was highlighted as a crucial cross-cutting area in that report, and a dedicated section on Modeling and Design tools can be referenced there.

This chapter provides background on the current status of energy–related integrated design and delivery practices, describes barriers to application of integrated design, recommends best practices and provides a set of recommendations for industry stakeholders to accelerate the shift to wider use of the ID process. Critical to these solutions is to reduce time and increase quality to effectively design and deliver a high-performance, low-energy building that persists functionally during regular operation.

GAPS AND BARRIERS

Over the last decade there has been frustration with traditional approaches to design and construction that remain sequential and segregated, constraining communication and cooperation among designers, builders and occupants. The design and construction process is fragmented to the point that subcontractors are generally unaware of important building system interactions. As a result, building systems operate largely independently, and sometimes against each other, resulting in inefficient energy use. Buildings that are expected to deliver outstanding performance while consuming much lower amounts of energy (with net-zero the ultimate goal) will require more refined, integrated design and delivery processes.

Complex interactions lead to natural variance. Yet as tolerances become tighter (e.g., lower infiltration, lower energy use), the natural variations become more significant. Inherent in this problem is the need for tools to address the complexity of major passive and active elements that affect energy in uncertain ways, as related to building location, orientation, thermal characteristics and intended use.

According to New Buildings Institute (NBI, 2007), “The barriers to the widespread design and construction of low-energy buildings are not technical in nature, nor do they appear to be financial; more likely they are related to the motivation of owners and the skill set of the design and construction teams." NBI continues, "Currently, there is limited practical guidance for design teams who may be ready to consider improvements to performance which would make their buildings 50% or more efficient than code. The uncertainties and time requirements of researching and implementing new approaches, and the associated performance risks, continue to be real-world obstacles to improved energy performance."

While the design and construction process places architecture and engineering firms in a position of significant influence, owners and their agents remain the principal decision-makers. Unfortunately, said decision-makers are generally unaware of the attributes of energy-efficient buildings, how those attributes align with their business interests, or how to obtain a higher performance building (what to ask for, the process to get it [integrated design] and how to evaluate it).

Typical project timelines and phases will support integrated design, but the amount of time devoted to different project phases will change. Virtually all members of the project team will shift hours to earlier in the project development phases. This additional time devoted to programming, conceptual design, schematic design and design development will generally save time during later phases. Nonetheless, there is resistance to paying higher fees to the team earlier than owners are accustomed to, and many consultants are not used to working in earlier phases of design.

At the highest levels of energy performance, and certainly at net-zero, occupants, operators and service providers need to take an active role in delivering performance. They must be engaged at the very start of pre-design discussions to set performance goals and explore the implications of schedules, establish the bounds of comfort criteria and consider the performance implications of individual (and collective) control of lighting and HVAC systems (whether automatic or manual). Occupants and facility staff need to be fully informed of how their actions enhance or degrade performance. Some mechanism (such as a lease clause) is needed for them to share the responsibility for performance. Appropriate contract models must also be in place with third-party service providers. Performance-based contracts should be considered.

The effort to redefine integrated design and integrated project delivery as a "new" practice has brought to light two issues:

- There is no commonly accepted definition or practice. Instead, there is an ever-growing number of definitions and approaches under the umbrella of "integrated design."
- There has been a certain amount of skepticism and resistance from people who believe they are "already integrating" their design and construction practice.

INDUSTRY RECOMMENDATIONS

1. A widely accepted standard for integrated design and methods for energy efficiency must be established by a nationally accepted authority and endorsed by key entities.

2. Increase awareness of the value of ID, standardized processes and roles of participants. Performance measurement and verification (M&V) should be universally expected of high-performance buildings. More widespread use of Post-Occupancy Evaluations (POE) will help evince the benefits of high performance by documenting environmental conditions and assessing occupant satisfaction.

3. Advance the integration of Building Information Modeling (BIM) with simulation tools to increase the role of energy modeling in building design. Provide support to strengthen the reliability, consistency and usability of predicted energy use and energy cost results. The goal is complete and accurate energy estimates earlier in the design process, along with improved lifecycle costing analysis.

4. Support development of tools that enable code officials to "plug and play" into the design team's process to check compliance and move the building along its design and delivery stages quickly and efficiently.

5. Develop tools that can assist net-zero-energy design teams, broadly defined, in revealing system dynamics to enable delivery of passive systems at reasonable cost and risk.

6. Gather existing demonstrations, case studies and other information, then package and promote them to the market. Work with others to collect cost data for entry into high performance building databases.

7. Financial incentives (such as utility programs) should be available to support whole-building design efficiency as well as provide support for elements of the process such as modeling and commissioning.

*For more discussion on the limitations and needed developments for modeling and design tools, please refer to the CBC *Next Generation Technologies Barriers and Industry Recommendations* report.

BENCHMARKING AND PERFORMANCE ASSURANCE

Energy-efficient performance is critical and necessary to achieving and assuring major gains in energy performance in commercial buildings. A building's performance is highly variable and complex, shaped by a web of dynamic interactions between physical structure, mechanical systems, facilities operation and management, occupant behavior and space use, and external factors like weather and climate. Many buildings designed and expected to perform efficiently are actually very inefficient, while some constructed 40 to 50 years ago outperform those designed in an era of rigorous energy codes.

In many cases we lack simple energy usage baselines and reliable energy performance metrics about commercial building stock. While our knowledge of building performance is limited, it is clear we can't make the meaningful strides to achieve broad-scale net-zero commercial buildings if we can't answer fundamental questions about how and why energy is used. Benchmarking and performance assurance are indispensable tools that increase our knowledge of energy performance, help identify improvement opportunities and measure progress toward net-zero.

Benchmarking refers to the establishment and use of metrics for comparison of energy performance. These metrics may include results from comparable (peer-group) buildings, a building compared to itself, best-practice references or codes, or a goal, such as net-zero. Benchmarks are typically expressed as an amount of energy used per unit of measure, most commonly the sum of the energy used per square foot, resulting in an energy-use intensity (EUI) metric. For a benchmark to be relevant and appropriate, the comparison should identify and eliminate the effect of neutral variables, those that affect total energy use but that are *not* being evaluated, such as operating schedule and climate.

Performance assurance addresses policies and practices needed to achieve and sustain building energy performance. The most cost-effective path to net-zero requires assuring best potential performance in the field prior to supplementing with renewable energy, then ensuring performance is maintained at net-zero over time. This includes the following measures:

- New and existing building commissioning.
- Ongoing commissioning, energy performance tracking and energy savings verification.
- Facility operations and maintenance.
- Occupant behaviors.

GAPS AND BARRIERS

Benchmarking

The barriers to widespread effective use of benchmarking as a means to improve energy performance fall into three categories: 1) the very limited and delayed benchmarking data available, 2) cost and accuracy issues with asset and operational evaluations and 3) the lack of effective connections between basic benchmarking results and clearly actionable information.

- Data Limitations. Limitations include the number of sampled buildings, frequency of sampling, timeframe for release of results and inclusion of sufficient data characteristics for complete normalization. We lack a richer database of sub-metered data, by building type.
- Tools and Procedures. ENERGY STAR Portfolio Manager uses a statistical scale that measures a building's performance relative to other buildings rather than a fixed or absolute metric, making it less useful in a zero-energy context. The ASHRAE Building EQ tool is set on a technical scale with zero-energy as the baseline but requires an energy audit (potentially expensive) to determine an asset rating. ASTM International's Building Energy Performance Assessment (BEPA) standard, currently under development, applies to the energy data collection and reporting process but does not specify any benchmarks. For asset evaluations, a methodology does not yet exist. ASHRAE's Building EQ labeling program is a potential solution; however, the high cost of an asset rating assessment is a deterrent.
- Programs. Existing programs (e.g., utility and state efforts) that impact energy efficiency are fractured and have no common protocol or procedures to collect measured performance results.
- Inconsistency. Inconsistent nomenclature, imprecise definitions of activity type, variations in measurement of building area and wide-ranging interpretations of occupancy and schedule all dilute the accuracy of benchmarking data.

Performance Assurance

The development of performance assurance processes is occurring in the U.S., but at a pace insufficient to move the market to net-zero within the desired timeframes. Lack of market incentives, barriers to technical integration and a lack of accountability with regard to energy performance goals are key issues of concern. While market incentives and programs exist that promote performance assurance, available financial incentives do not spur action on either a large scale or at an integrated whole building level:

- Incentives to save energy are misaligned. Often the parties with the greatest ability to impact energy use have the least incentive; for example, O&M staff and occupants are not provided the tools or training to understand potential impacts.
- Utility energy efficiency programs are not viewed as a resource on par with supply-side options.
- Historical approaches to energy savings are based on incremental technology measures rather than more integrated solutions.

Additionally, there is a lack of accountability for energy performance and consistency of delivery processes:

- While energy performance goals are becoming widespread, no entity is accountable to meet design or operation targets.
- Inconsistent commissioning scopes are specified, and varying results are delivered to owners.

Lastly, technical limitations to sensors and controls impair both data collection for benchmarking and prognostics and diagnostics for building energy monitoring and maintenance. These technical challenges are addressed in the CBC *Next Generation Technologies Barriers and Industry Recommendations* report.

INDUSTRY RECOMMENDATIONS

Benchmarking

Effective benchmarking requires more data availability and a suite of tools to create useable feedback from the whole building to the more granular level of occupant, system and operating characteristics. Actions to fill the above gaps and circumvent the barriers include:

1. *Encourage improvements in existing commercial buildings energy consumption surveys, including depth of coverage, frequency, and methodology.* Databases of sub-metered data for all building types should be developed.

2. *Establish and develop a national measured performance database.* Alternatives to existing commercial buildings energy consumption surveys, even if they do not generate a statistically representative picture of all regions of the country or new construction, are essential to foster competition to be the best and/or achieve more fixed goals such as net-zero energy usage.

3. *Gather energy data on all public buildings in the next five years.* This important and diverse data could be used to test and inform benchmarking and retrofit strategies for the private sector while making significant energy efficiency gains in the public sector.

4. *Standardized Data Collection Methodology.* It is recommended that government agencies seriously consider industry efforts directed at standardizing data collection methodology, such as the ASTM BEPA standard.

5. *Monitor Asset Evaluation*. Experience gained in the asset rating of ASHRAE's Building EQ program over the next few years should provide sufficient information on which to base other asset rating programs and procedures. California is also developing and intends to pilot an asset rating system. It is recommended that the Commercial Energy Services Network or COMNET normalization procedure for energy modeling input variables be viewed as the standard procedure used in all asset evaluation programs. Prototypical building models (e.g.,

such as that which can be found in the Commercial Building Benchmark Model project) should be continually developed and maintained for standardized use.

6. *Untie restrictions on disclosure of existing building energy use data sets.* Facilitated access for research and benchmarking purposes would be a major step forward, including utility billing information.

7. *Increase availability of automated benchmarking data*. Implement approaches taking advantage of modern smart-grid data availability (e.g. interval data), building management systems, data management and communications technologies to create an automated method to populate the minimum required information.

8. *Improve normalization capabilities and other inconsistencies in benchmarking assumptions*. Foster consistent use of a single set of activity types with unambiguous definitions and protocols for normalization.

9. *Promote better tools for interpreting and acting on benchmark results*. Support easy-to-use high-level tools and metrics that extract as much useful insight as possible and translate from basic metrics to actionable information.

10. *Support scales such as the Zero Energy Performance Index*[5] *(zEPI) for credible, forward-looking benchmarks.* Forward-looking benchmarks are essential, rather than reliance solely on historic norms and benchmarks.

11. *Train building operators on the use of benchmarking.* Provide training on simplified tools and benchmarking to the majority of building operators.

Performance Assurance

The commissioning process must be integrated throughout delivery and operation. The increasing complexity of systems and integration requirements may lead to more scalable solutions in a service provider model or for large portfolios. Three key recommendations, that would require additional financial incentives to demonstrate, are:

1. *Create a framework for accountability and verification of building performance in design, construction and operations.*
    a. Newly constructed buildings should be quickly calibrated to actual performance to help identify when they fail to meet targets. Additional code triggers for performance assurance over time (point of sale, renovation, lease, periodic) are important for maintaining and improving performance of the existing building stock.

[5] A metric where 100 equals the average energy use intensity of a building in the year 2000 and 0 equals net-zero.

b. Define accountability for performance and set benchmarks by building type. Owners should be accountable for meeting performance targets (they may pass this accountability on to their design and operations teams). Occupants will need plug-load requirements.

c. Such a framework would underpin a successful long-term continuous energy improvement strategy in commercial buildings.

2. Demonstrate the feasibility of delivering systems that integrate all building energy performance components and track performance over time. Net-zero energy buildings will need to integrate loads (HVAC, refrigeration, lighting and plug loads); generation (distributed generation and CHP); and demand response to cost-effectively achieve targets in a standardized scalable fashion.

3. Determine the value of net-zero energy buildings and demonstrate proactive business models for delivering energy performance through pilots and partnerships. For new buildings, integrated design and operations approaches should be tested and, if valid, promoted. In existing buildings, various business models for assuring integrated performance in scalable ways should be tested along with innovative mechanisms for incentivizing occupants to save energy.

VOLUNTARY PROGRAMS

The Voluntary Programs Working Group has identified a number of programs, incentives and green building initiatives that significantly advance the pathway for commercial buildings to achieve net-zero. For purposes of discussion, these activities were grouped together under the following major headings:

- Tax Incentives
- Rebates and Grants Programs
- Utility Incentive Programs
- Green Building Voluntary Rating Systems
- Green Building Codes and Standards
- Green Building Incentive Programs
- High Performance Building Recognition Awards

After assessing current state-of-the-art activities, the group analyzed the primary gaps and barriers negatively impacting advancement toward net-zero. The working group concluded its discussion by providing recommendations on action items federal agencies and national partners should consider incorporating as part of a national commercial buildings initiative.

GAPS AND BARRIERS

Tax Incentives

- Tax incentives usually come with time-consuming application processes that do not coincide with the real estate commercial development cycle.
- Sometimes tax incentives need to be extended through statute or they will expire, creating uncertainty in the market.

Rebates and Grants

- In bad economic markets, many states and local governments cannot fund rebate and grant programs.
- There is a lack of strategic alignment between rebates and grants and between state and local utility programs for various energy efficiency measures that could create synergies and deeper energy savings.

Utility Incentives

- Traditional regulatory utility rate structures that do not value or 'monetize' efficiency represent a significant barrier to effective utility energy-efficiency programs.

- Many utilities across the United Sates have profits linked to sales of electricity and natural gas, creating a disincentive to investment in efficiency.

Green Building Voluntary Rating Systems

- Most green building certification programs do not require a building to have low or net-zero energy use.
- Inexperienced designers or architects may cherry-pick points to meet a target certification level, even though those points may not be the best design choices for energy efficiency in a specific building or climate.
- Most programs rate and certify buildings at specific points in time, for example at initial occupancy, which does not reflect ongoing energy consumption or actual building performance over time.

Green Building Codes and Standards

- Green buildings codes are just entering the market. Many building officials, plan checkers and field inspectors lack the training and resources necessary to enforce new code requirements.

Green Building Incentives

- In bad economic markets, local jurisdictions cannot afford to reduce or waive permit fees (which help pay for staff salaries and other operating expenses).
- Green power is usually more expensive than conventional fossil-based energy.

High Performance Building Recognition

- Recognition awards are typically valued for their inherent exclusivity and as a business marketing tool. Too many recipients dilutes the distinction of being a leader in the field.
- There is no common set of selection criteria among the various awards.

INDUSTRY RECOMMENDATIONS

1. *Consider expanding tax credits for high-performance buildings.* These credits will apply to a range of technologies and energy conservation measures, from wind turbines, photovoltaic systems (PV) and cogeneration to efficient interior lighting, weather stripping and building insulation.

2. *Financially support utility energy efficiency rebate programs that reward high-performance buildings delivering deep energy savings.* California and Oregon have initiated new program elements that provide additional incentives to secure deeper savings, both in new construction and substantial rehabilitation.

3. Promote revenue decoupling for utilities nationwide to increase the scale and scope of utility-sponsored energy efficiency programs. As is the case in the Northwest, decoupled utilities should be allowed to recover the cost of implementing energy efficiency incentive programs. Investor-owned utilities should be able to generate shareholder earnings in return for successful implementation of energy efficiency incentive programs. Approximately two billion dollars of approved investments in efficiency were implemented from 2006 to 2008 alone. It is estimated that every dollar invested by the utilities in efficiency measures has generated more than two dollars in customer savings.

4. Support development of increased energy efficiency performance within voluntary green building rating systems, including continued verification of building performance over time.

5. Promote the adoption of increasingly more stringent green building codes that emphasize energy efficiency standards. No incentive- or market-based program can achieve the market penetration routinely achieved by codes. To achieve net-zero energy, green building codes that focus on energy efficiency measures need to be a driving policy instrument and ultimately the mechanism by which net-zero is broadly achieved.

6. Encourage local jurisdictions to expedite building plan review and permitting processes for high-performance green buildings with an emphasis on energy efficiency.

7. Support national, high-profile recognition award programs for exemplary high-performance buildings showcasing excellence in sustainable design and reduced energy consumption. The AIA/COTE Top Ten Green Projects program, now in its 14th year, is the architectural profession's best-known program for recognizing sustainable design excellence. However, it has no clear target or requirement for energy reduction.

FINANCE AND VALUATION

The objectives of this element of the report are to identify and characterize the market barriers and transformation strategies associated with finance, valuation, and appraisal. This section assesses existing policies and programs implemented to date and identifies the characteristics and strategies of successful program implementation and makes recommendations on what promising solutions and approaches may warrant additional resources or complementary policies.

Finance activities within the commercial building sector must address a diversity of submarkets, each with its own ownership, investment and finance ecosystem as well as a wide range of cost-sharing structures for energy use among owners and occupants. Taken together, the clusters of finance activities span from pure public sector economies to pure private sector economies, with a full range of public/private and institutional nonprofit activities in between. This reality of a balkanized marketplace makes any single, sweeping discourse around finance and appraisal particularly confusing to market actors, who are likely specialized in one of the several submarket categories.

Given the diversity of the commercial building submarkets, a range of finance and appraisal innovations are currently being explored, innovated and implemented. With the economic downturn shifting business attention to the management of existing real estate assets and away from bringing new real estate product to the marketplace, private owners have demonstrated heightened emphasis on maximizing building operation and management activities.

GAPS AND BARRIERS

Several in-depth studies have documented that typical energy efficiency improvements are being paid for out of conventionally allocated building operating budgets with a typical finance term of 2-3 years (or less). These investments are not typically financed through a dedicated finance vehicle but are treated as ongoing O&M projects. There is a need to move investments from the operating budget (1- to 3-year term) to capital budgets (15-, 20-, 25-year term) to reach deeper savings. At the same time, coordinated action and response between the parties responsible for the two separate budgets can yield more savings on both the O&M and capital improvements side. This is especially relevant to the success of energy efficiency and energy conservation measures which rely heavily on proper maintenance of equipment and systems and occupant behavior.

The “first-cost” hurdle to energy efficiency improvements elevates the importance of access to capital across all submarkets. Issues include:

- Competing uses of capital within an owner's real estate portfolio.
- An unwillingness to commit capital to "non-core" investments.
- The structure of many leases results in split incentives, making projects unattractive.
- Transaction costs are high, or perceived as high.
- Energy cost savings may have limited impact on overall financial position in an asset.

In accessing external financing, a variety of other barriers exist, including:

- Pre-existing mortgage liens may render an efficiency loan subordinate to a significant amount of existing debt. Existing mortgages often restrict additional debt financing.
- Lack of transparent data on financial savings from efficiency measures make it difficult for owners to "pull the trigger" and for lenders to underwrite loans.
- Efficiency is not incorporated in most real estate valuation, limiting the value proposition for both property investors and lenders.
- Limited track record on investment performance results in relatively high lender risk premiums.

INDUSTRY RECOMMENDATIONS

Industry awareness of the importance and vast market potential of energy efficiency is at an all-time high, yet the current economic climate creates significant challenges related to financing options. The current state of the commercial real estate market (with many properties substantially overleveraged) presents both an obstacle and an opportunity to include efficiency retrofit measures in restructuring and workout situations.

1. Providers of private capital need to increasingly work with utilities and policy-makers to meet the country's growing energy and environmental challenges. All financing options assume the existence of utility, local, state or federally-funded energy efficiency programs. The ability to leverage cash incentives or rebates offered for selected efficiency measures and technologies as well as the provision of technical assistance to help identify and develop project opportunities are critical roles to support private capital.

2. Drive more information into all segments of the marketplace, increasing awareness of language and terminology across all participants. Structure educational initiatives around "new" information. Innovation in finance practices is not reliant on individual new tools or mechanisms but rather on deeper saturation of knowledge which can be used to better define value within the context of ongoing transactions.

3. Financing alone cannot lead to the realization of established energy and energy efficiency goals. Key options include the adoption of "decoupling-plus" regulatory regimes for utilities that not only break the link between electricity sales and profits but also set earning incentives and penalties related to meeting energy efficiency targets and revised tax incentives and depreciation rules to place energy efficiency on par with renewable energy (e.g., accelerated depreciation, investment tax credit inclusion and property tax exemptions).

4. Add layers of credit enhancement. Credit enhancement improves pricing of capital, mitigates investment risk that is difficult to quantify or price and can facilitate access to additional pools of investment capital.

5. Establish revolving loan funds for public sector financing. Use public funds to lend in sectors that provide a public good but cannot be effectively funded with private capital. Capital that would otherwise be granted is repaid and reused. As these public funds revolve, they present opportunities for program modification and refinement to better adapt the financing mechanism to changing market needs over time.

6. Broaden local finance mechanisms to embrace energy efficiency, including the many conventional urban development vehicles used by municipal government to effectuate public infrastructure investment in concert with economic development. This strategy would require clear justification of energy efficiency as a local public benefit, establishment of dedicated secondary markets, further refinement of property-based clean energy assessment strategies, use of district-based tax-increment finance (TIF) in conjunction with district-based demand response initiatives, and addressing community concerns around debt ceilings, administrative capacity and impacts on credit ratings.

7. Increase sophistication and transparency of energy efficiency benchmarking data. If you measure, manage and finance it as energy, you unlock the ability to deploy it at scale. Explore mandated building performance benchmarking such as New York City's Greener, Greater Buildings legislation, develop or approve protocols for benchmarking and compliance options, identify business types expected to benefit from energy efficiency investments, identify tools, instruments and information necessary to attract capital to energy efficiency and promote more detailed, real-time measurement of building energy use.

OWNERS AND TENANTS

Commercial real estate, especially office buildings, have been an energy efficiency challenge for decades. Complexities include multiple tenants, the relatively small size of individual leased space, speed of the tenant improvement process and split incentives.

Given this history, engaging the multi-tenant market in the goal of net-zero energy will first require its involvement in comprehensive energy efficiency. The Owner and Tenants working group recommends that a focus on currently achievable energy savings targets is the best way to engage the commercial real estate market on the path toward net-zero buildings.

Encompassing existing commercial real estate is critical on the path to net-zero. The national commercial office market consists of 1.6 billion sq. ft. of downtown office and 3.4 sq. ft of suburban office space (*Colliers International 2009 U.S. Real Estate Review*).

GAPS AND BARRIERS

Split Incentives
Otherwise known as the “principal-agent market barrier,” split incentives are a well-documented barrier to energy efficiency. Who pays and who benefits from energy efficiency depends on the terms outlined in the lease. In addition to leases, other contracts in commercial real estate also create split incentives that prevent widespread adoption of energy efficiency, including property management agreements, due diligence, underwriting standards and broker contracts.

Informational Barriers
A number of informational barriers prevent widespread adoption of energy efficiency. The typical leasing and tenant improvement process involves a large number of market actors, few of which are technically savvy. Furthermore, the industry lacks the robust and ongoing monitoring and verification necessary to provide feedback to the design community on strategies that improve the energy performance of commercial buildings. Specific barriers include confusion and/or lack of available information about:

- Energy use in buildings, especially in tenant spaces.
- Costs and benefits of the design, construction and energy use associated with various energy conservation strategies.
- Incentive programs and tax deductions to help offset costs of energy efficiency improvements.

Tax Policy
Tax policies, specifically depreciation schedules, can restrict investment in energy efficiency.

District Energy Policy
Most buildings in urban centers will be difficult to make net-zero energy with on-site renewable energy due to their size, density, and shading. A typical commercial building has its own energy conversion plants (chillers, boilers, furnaces) that serve only the needs of the building itself. In a climate benefit district (CBD), the district spans the boundary with efficiency integrated into the buildings and a district-wide green infrastructure and green power production on site. The building efficiency and generator components support the entire district. From a financing perspective, it looks to a district-wide investment profile rather than to individual buildings, essentially aggregating and monetizing the difference between neighborhood baseline energy and high-performance use. Essential components for success include demand reduction through building efficiency, new supply through recovery and generation and neighborhood (public realm) integration. There is a lack of policies and mechanisms to support innovation and investment in district energy systems. For more technical discussion of district or multi-building systems, please refer to the Multi-Buildings Section of the CBC *Next Generation Technologies Barriers and Industry Recommendations* report.

INDUSTRY RECOMMENDATIONS

While first cost was noted by the Owner and Tenant working group as a major barrier, it is being addressed by the Finance and Valuation working group. The other barriers are more specific to the Owner and Tenant group.

1. In order to address the split incentive, a variety of corporate real estate contracts should specify the measurement criteria and performance levels sought for energy. While there is no such thing as a 'green' lease, owners and tenants are beginning to understand it is in their best interest to clarify who pays the costs and receives the incentives and energy benefits of efficiency.

- Explore common commercial real estate transactions to learn how to explicitly address and incorporate opportunities for improving energy efficiency. These include development agreements, service contracts, broker representation agreements, asset management contracts and insurance agreements.
- Develop and promulgate guidance to owners and tenants on what elements should be considered as part of a 'green' lease supporting enhanced energy performance.
- Encourage development of standardized protocols for reporting energy performance and any opportunities for improvement that can be used during the due diligence and underwriting processes.
- Support research that clarifies the link between energy efficiency and building value.

2. Require transactional energy disclosure regulations and related policies focused on identifying and addressing energy inefficiency in commercial real estate. This transparency will identify potential valuation impacts and facilitate negotiation of energy efficiency remediation investments into routine commercial real estate transactions.

- Support regulatory approaches such as that implemented in New York City (requires routine disclosure of energy consumption information from tenants to landlords).
- Implement the recommendations of the Benchmarking and Performance Assurance group to improve the transparency and quality of information about building performance.

3. Support increased financial incentives and tax rebates to support energy efficiency.

- Encourage streamlining of utility incentive programs across service territories, such as the Office of the Future Consortium of utilities working to increase commercial real estate participation in utility programs.
- Conduct a formal review of federal tax policy to better understand how it may preclude energy efficiency and develop solutions to address it.
- Continue supporting the DSIRE database of utility incentives.

4. Support interdisciplinary public/private partnerships to create groundbreaking high performance building districts in downtown areas. New efforts in multiple urban centers are developing realistic, measurable and elegant strategies to assist district property owners, managers and tenants in meeting goals that aggressively reduce environmental harm from facility construction and operations.

- By working within one geographical area, owners can share tools, district solutions, information and lessons learned on climate-responsive design solutions.
- Develop mechanisms and pilots to support CBDs that combine deep building energy efficiency and green power generation to support the entire district. From a financing perspective, a district-wide investment is supported (rather than just individual buildings), essentially aggregating and monetizing the difference between neighborhood baseline energy and high-performance use. CBDs can aggregate and smooth efficiency performance thus creating a more reliable and consistent resource supply and financial returns.

*5. Supplement existing high performance buildings databases*to include more information on measured performance and costs associated with particular strategies.

WORKFORCE DEVELOPMENT

The workforce issues addressed herein include all positions involved in the design, construction and operation of net-zero-energy commercial buildings. This scope includes the workforce needs on the critical steps along the way to net-zero, such as energy efficiency retrofits and operations. Also considered is the role of K-12 education in providing an essential building block for the workforce's long-term development. Excluded from consideration are workforce needs associated with development and manufacturing of the technologies that enable net-zero-energy buildings.

This report focuses on commercial buildings, which are larger, fewer and more complex than the mass of residential buildings. The workforce associated with the commercial segment differs accordingly in that fewer low-skill entry-level construction positions are available, and there are no broad mechanisms like the national Low-Income Weatherization Assistance Program to support training and development.

Five categories of jobs were considered:

- Design professions, which include architects, engineers and specialists such as energy auditors, modelers and commissioners.
- Construction, which includes contractors, trades people and construction inspectors.
- Property Management and Operations, such as property development, operations and purchasing.
- Utility companies, in that utilities are a significant part of the delivery of energy efficiency services, from provision of incentives to project delivery.
- Finance, Insurance, Real Estate (FIRE), as improved knowledge is the key enabler for the market, especially in real estate investment and underwriting.

GAPS AND BARRIERS

In the near-term, there is a lack of integration of multi-functional teams and communications across disciplinary lines. While it is important that skills and curricula be focused on individual segments and disciplines within the building process, it is crucial that the segments and disciplines come together to realize net-zero-energy buildings. This will require increased focus on the building itself as a system - the interaction of numerous systems to achieve an end result. The synergies and potential conflicts of the various individual systems must be examined and understood. This requires communication in a common language and a willingness to engage in discussions across disciplines. All segments of the building community must be able to work as part of a team with a common goal: a net-zero-energy building.

In the mid-term, there exists a lack of understanding on the added value of energy-efficient projects. Awareness building and education targeted at trades professionals and the workforce will help communicate that measurable energy improvement can validate good work and differentiate a professional from his or her competitors. Furthermore, there is a lack of clarity and consensus about the skills and knowledge needs for various workforce segments, making it difficult for trainers to provide training and continuing education in energy efficiency.

More fundamentally, trainers tend to trail the market and will not prepare people for jobs that do not exist or equip them with skills they will not use. Defined career paths and job placement opportunities are necessary for trainers to demonstrate their success and secure funding for their programs and operations. Ultimately, trainers can only react to the market; the potential to drive the market lies with the FIRE community. How can the demand be mobilized through the supply chain of FIRE, design and construction and long-term forecast of demand? Other endemic issues include concerns about "training other people's staff" (i.e., labor mobility) and corporate under-investment in training. There is also a multiplicity of efforts with overlapping but not agreed-upon standards.

Finally, in the long-term there is a very limited effort in K-12 education specifically focused on building sciences. Beyond the need for a trained workforce in the near-term, we must ensure that tomorrow's building professionals are in the pipeline with the requisite skills and interest to enter the professions. The building community has a significant opportunity to reach students through the issues that interest them: sustainability and technology. Net-zero energy buildings embody the sustainability movement and will inevitably require new and innovative technologies. Getting this message to students early and often will pique their interest in the building professions as a career.

INDUSTRY RECOMMENDATIONS

1. *Create a clear picture of zero energy and how it's achieved.* Providing an operable definition and pathway to achieve net-zero energy buildings will better define workforce needs.

2. *Build clarity and consensus around workforce requirements.* Focus on the necessary skills, standards, certifications and curricula that must be developed. Map career pathways. Endorse and reinforce existing leading-edge efforts at multiple levels.

3. *Create labor market mechanisms.* Strengthen and confirm early market projections related to net-zero energy buildings. Conduct further sector-specific labor market research. Create jobs training and incentives for training program participation and internships. Utilize collaborative opportunities through workforce investment boards (WIBs) under the Green Jobs Act framework.

4. *Adopt and spread known best practices from K-12 through university.* Improve teacher training in energy curriculum. Provide guidance on career opportunities. Develop better collaboration between colleges, industry and labor.

5. Create a zero energy workforce commission that will bring together major institutional interests to coordinate activities, standards, programs, etc.