Bringing the Commercial Buildings Sector under One Roof: Mobilizing Broad Stakeholder Collaboration to Accelerate Market Transition to Net Zero Energy

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ABSTRACT

Transforming the commercial buildings market to achieve dramatically lower levels of energy use 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. Many stakeholders—including industry and professional associations, voluntary high-performance building organizations, codes and standards organizations, the federal government, leading utilities, state and local agencies, private building designers, developers, owners and operators, and equipment manufacturers—will need to participate actively and in concert to effectively restructure today's standard design-build-operate process.

In response to the need for more aggressive and effective action, the Commercial Buildings Consortium, a multi-year public/private initiative is underway, focused on achieving sector-wide transformation through coordinated technology development, demonstration, and deployment supported by major innovations in policy, financing, project design and delivery, and building energy management. Industry stakeholders have convened a broad-based consortium, which is organized around 11 working groups covering topics ranging from building envelope, systems and controls, integrated design and delivery, benchmarking and performance assurance, financing, and workforce development, with the primary objective of accelerating needed technology innovation, process change, and market transformation. Through development and dissemination of a *Next Generation Technologies* report and an *Analysis of Cost and Non-cost Barriers and Policy Solutions* report, the more than 340 consortium members are developing and delivering strategies and best practices to achieve a market transition to net zero energy[1] new commercial buildings by 2030 and all commercial buildings by 2050.

Introduction

A consensus is growing on the need for aggressive public and private action to deal with increasing energy costs and the threat of global climate change. In the U.S., buildings account for approximately 40 percent of total energy consumption and 40 percent of greenhouse gas emissions (DOE EIA 2010). About half of this is attributable to the commercial sector, and commercial building energy use is growing more rapidly than residential sector energy (DOE EERE 2009a). 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.

[1] The term "net-zero" energy is discussed in more detail below, but generally refers to a building that uses no more energy than can be produced on-site over a one year period.

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 (DOE EERE 2009a). In recognition of the need for a coordinated, broad-based industry effort, several leading organizations, including AIA, ASHRAE, USGBC, and LBNL,[2] convened a series of meetings, culminating in a day-long workshop in October 2006. As an outcome of that workshop, the group developed the Commercial Buildings Initiative Action Plan based on a number of structured interviews with industry leaders and proceedings from two larger workshops held in late 2007 and early 2008 with support from the U.S. Department of Energy (DOE). As originally envisioned, the goal of such a public-private partnership was to "reshape the overall 'invest – design – build – operate' playing field for commercial buildings so that zero energy buildings become the expected norm in less than 25 years" (Selkowitz et al. 2008, 2).

In 2007, those early efforts were vindicated when Congress created the Zero Net Energy Commercial Buildings Initiative (CBI) as part of the Energy Independence and Security Act (EISA) (P.L. 110-140, §421, 422 *et seq*.). Congress set national goals for the CBI to develop and disseminate technologies, practices, and policies for establishment of zero net energy commercial buildings, with major milestones of achieving zero net energy performance: 1) for new commercial buildings by 2030; 2) for 50% percent of all commercial buildings in the stock by 2040; and 3) for all U.S. commercial buildings by 2050. The EISA legislation authorized DOE to collaborate with national labs, the private sector, other federal agencies, and non-governmental organizations in an effort to achieve these goals, and directed DOE to recognize and competitively select a broadly representative public-private commercial buildings consortium.

DOE officially launched the Commercial Buildings Initiative (CBI) in August 2008 and in 2009 took steps to recognize the Zero Energy Commercial Buildings Consortium (CBC). As a result of a competitive solicitation, DOE provided funding to the CBC to coordinate private and public sector involvement in technology and market assessments along with other activities to help accomplish the CBI goals. Since Congress authorized this initiative in 2007 the DOE budget for commercial buildings has grown to $33 million in FY09 and $39 million in FY10,[3] thanks to strong support from several industry advocates and non-government organizations. Additional resources from the American Recovery and Reinvestment Act demonstrate continued federal commitment to the CBI goals.

Getting to Net-Zero Energy: The Road Ahead

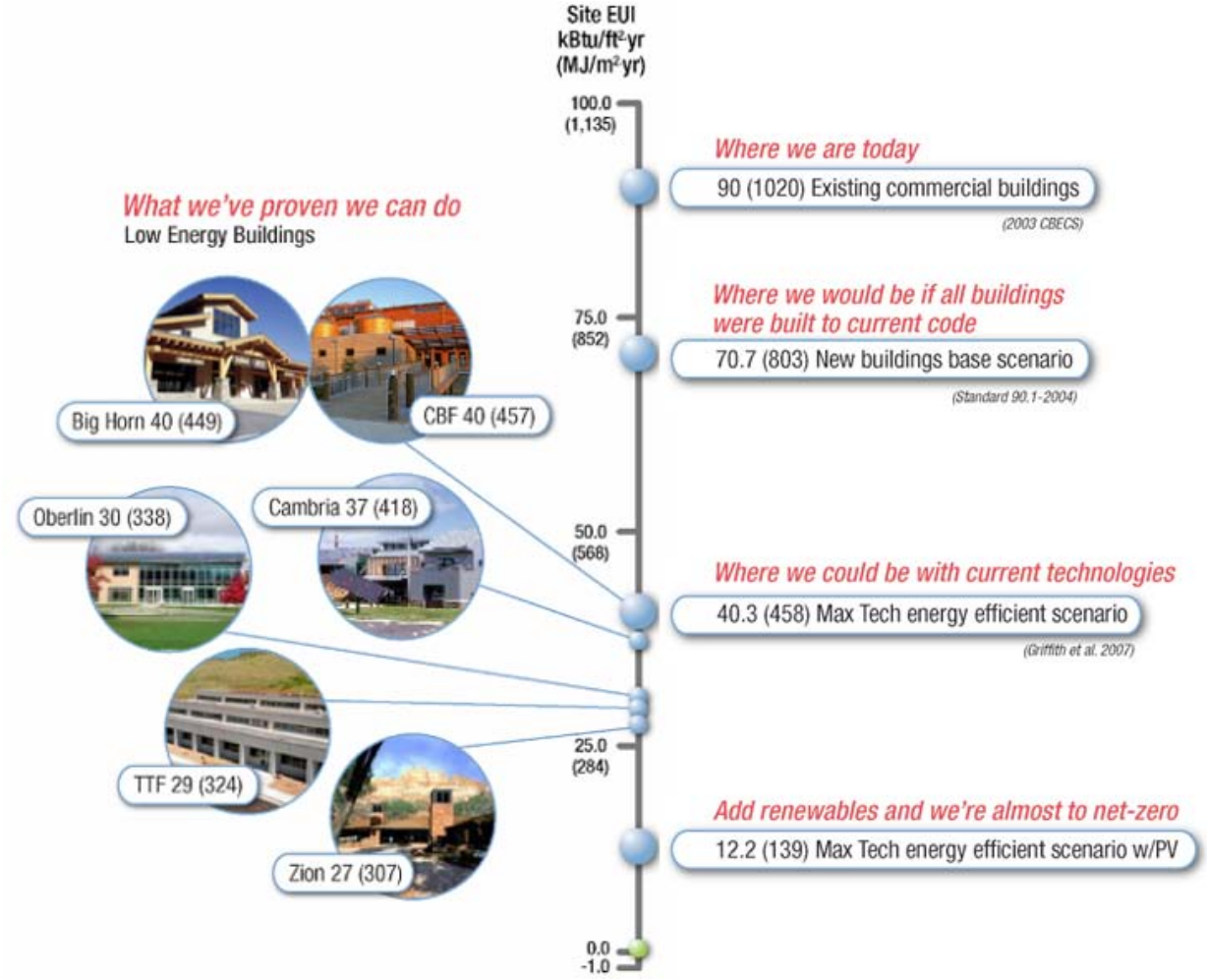
Getting all new commercial buildings to achieve net-zero energy routinely will be a major undertaking, as shown in Figure 1; the task is even more challenging for the existing building stock. The average site energy use intensity (EUI) for commercial buildings today, based on the 2003 Commercial Building Energy Consumption Survey, is 90,000 Btu per square foot per year (DOE EIA). If all commercial buildings were built to current energy code (ASHRAE 90.1-2004), the sector could achieve about a 20% reduction in energy use. With today's technologies and best practices, a few buildings have been able to reach between 55%-

[2] American Institute of Architects; American Society of Heating, Refrigeration, and Air-Conditioning Engineers; US Green Building Council; Lawrence Berkeley National Laboratory.

3 The $39 million figure is from the FY11 budget request, since the FY10 Omnibus did not separate out line items under Commercial Integration.

70% energy reductions, and by maximizing energy efficiency and adding on-site renewables, at least eight have been designed to reach net-zero energy, measured on site on an annual basis, though these buildings are all relatively small, averaging roughly 6,000 sq.ft. with the largest being only 13,600 sq. ft (DOE EEREb). In general, these buildings also have modest internal process loads and normal operating hours—unlike most restaurants, hotels, hospitals, laboratory research buildings, and data centers, etc. Moreover, these pioneering zero-energy buildings, with a few exceptions, are often located in moderate climates rather than areas with very high winter heating loads or summer cooling and dehumidification requirements.

Figure 1. Average Results for EUI for Current Stock, Minimum Standard and Max Tech Scenarios



Source: Griffith et al. 2007, xii

Ultimately, efforts to transform the commercial buildings sector will need to advance the curve by accelerating the shift from today's best practice to standard practice and eventually to minimally-accepted practice. The small number of high-performance and zero energy buildings in the market demonstrates how challenging it is to overcome various barriers in the commercial building sector. Presently, only a handful of building teams, driven by a dedicated and well-financed owner or developer and supported by experienced and innovative design, construction,

and building operations personnel can produce ultra-low-energy or zero energy buildings. Even then, the building is likely to be small and relatively low-rise, to provide a reasonable ratio of roof area (for photovoltaics (PV) or/and solar thermal collectors) to total floor area. Yet low-rise buildings also limit development density, and density is fundamental for investments in public transit and other development practices that enable energy savings beyond the building perimeter at the neighborhood and urban scales. The challenges ahead are to improve technology, bring down costs, and most importantly, make it easier for everyone involved in the building process to be invested—personally and institutionally as well as financially.

Net Zero Energy Buildings: Understanding the Goal

Reaching agreement on a common definition of net-zero energy is not a simple task. Policymakers, building designers, and owners/developers all play a role in defining net zero energy in terms of their own goals and objectives for a zero-energy building. (Torcellini et al. 2006) In EISA (P.L. 110-140, §422), Congress defines "zero-net-energy commercial building'' to mean a high-performance commercial building that is designed, constructed, and operated so as:

- To require a greatly reduced quantity of energy to operate;
- To meet the balance of energy needs in a manner that will result in no net emissions of greenhouse gases; and
- To be economically viable.

Although the CBC has not adopted a formal definition of a NZE building, we accept the need to focus on technologies and policies to enable high-performance commercial buildings that maximize energy efficiency to achieve very low energy use that could be supplied with on-site renewable energy production over the course of a year, taking into consideration: GHG emissions; economic feasibility; load-shape impacts on the utility grid and other customers; indoor environmental quality and occupant comfort and amenity; energy embodied in construction; transportation energy indirectly required for occupant and user access; and efficient use of water and other non-energy resources. At present, the CBC will focus on how to achieve major reductions in energy with those other factors in mind, recognizing that a more precise definition will have greater significance as we get closer to zero.

Barriers and Solutions

According to an assessment by the National Renewable Energy Lab (NREL), with today's technologies and practices, 22% of commercial buildings could potentially be net-zero site energy (Griffith et al. 2006). However, in practice, the DOE's Zero Energy Buildings Database has recognized only eight net-zero energy projects (DOE EEREa). So what is preventing the commercial building sector from reaching the possible 22%? And what will it take to expand today's theoretical potential to 100%—and further, to realize it in practice?

To start with, higher costs and lack of information present major barriers to scaling up zero energy buildings. Initial costs for energy-efficient buildings and investments are often higher than costs for standard buildings, and as long as energy costs remain a small portion of total operating costs, the trend will be slow to reverse. However, the industry's perception of

that cost is even higher than the actual. According to a report by the World Business Council for Sustainable Development (WBCSD), on average, building professionals in the U.S. estimated a 16% cost premium for "greener buildings," but in reality, the cost premium of achieving the highest level (platinum) of Leadership in Energy and Environmental Design (LEED) is less than 10% (WBCSD 2007, 31).

Efforts to raise awareness will have to focus on multiple audiences. Building owners represent a primary audience to target since they are key decision-makers and stakeholders in each stage of the process, from investment to design to construction and to operation. Presenting a strong business case for zero energy building and its ancillary benefits to owners may help to overcome the misperceptions of high cost.

For investors and developers, tools and information that emphasize life-cycle costs rather than initial costs may shift the traditional focus from maximizing short-term profits to a longer view (WBCSD 2009, 42). Increased investment in and attention to workforce development for professions along the entire chain of building design, delivery, and operations, including architects, engineers, contractors, commissioning agents, building operators, energy auditors, energy managers, and appraisers, is needed to provide the technical expertise and capacity to scale up the delivery of high-performance, low-energy buildings.

Lastly, improved diagnostics and feedback on actual energy performance can make energy visible and decisions relevant to building owners, operators, and occupants. In a 2007 study, CoreNet Global found that only two-thirds of companies surveyed tracked energy data and only 60% tracked energy costs (WBCSD 2007, 31). Efforts to make energy performance information more visible and understandable to owners, operators, and occupants, who have competing priorities and demands, can increase the chances for different choices and build the foundation for closing the gap between a building's as-designed and actual energy performance. Proposals for routine or periodic tracking, benchmarking, and disclosure of energy performance in commercial buildings are becoming more common, often building on the Energy Star Benchmarking and Portfolio Manager tools.[4] States such as California and Massachusetts and cities including Washington, D.C. and New York City are calling for the disclosure of energy performance information to owners (often beginning with public buildings) and to prospective buyers and tenants.[5]

Besides higher costs and lack of information, the highly diverse and fragmented nature of the commercial building sector presents a whole host of challenges. Commercial buildings vary not just by size and climate, but also by use and occupancy type. For the purposes of the CBC, the commercial buildings sector includes office and retail buildings, schools, hospitals, hotels and restaurants, government buildings, and mixed use buildings which may encompass any of the above. In some cases, building designs may be developer-driven and not owner-driven, meaning the eventual owner may have little or no say during the design process. Nearly half of all non-government-owned commercial buildings in the U.S. are not owner-occupied (DOE EIA 2003), and many of these buildings have multiple tenants—both of which create split incentives in energy efficiency investments and energy conservation behavior. Furthermore, over the lifetime of a building, occupants come and go, and the way they use the building can vary drastically from how the building was designed.

To further complicate things, a segmented and sequential design and construction process forces developers, designers, and owners towards isolated and insulated decision-making,

[4] For Portfolio Manager see http://www.energystar.gov/index.cfm?c=evaluate_performance.bus_portfoliomanager.
[5] Several of these programs are summarized at http://www.imt.org/benchmarking-and-disclosure.html

limiting the ability of downstream actors to optimize energy-saving design features. Additionally, development patterns, zoning laws, and design and construction practices and expertise are all highly localized, making it difficult to share best practices and lessons learned quickly. These realities play a role in reinforcing the risk-averse nature of the commercial building sector, and though some programs have begun to deal with these issues (e.g., Savings by Design (California) and Better Bricks (Pacific Northwest)), they is still have a long way to go. Developers are used to doing what they have always done, and they are reluctant to change practices that have ensured consistent levels of performance, even if sub-optimally. Changing one measure may mean circling back to reexamine and recalibrate other affected systems, which can create delay and incur costs or risk noncompliance with health and safety standards and building codes.

To overcome the inertia in the system and break down the walls among the different stakeholders to achieve the ambitious goal of net-zero energy will require broad and dedicated industry support. At the same time, additional research and development to improve energy performance in buildings will be needed to continue to augment the suite of available and emerging technologies. In particular, one technical challenge will be to develop plug and play integrated technology packages and better-integrated systems with more sophisticated diagnostics and self-correcting mechanisms (NBI 2007, 2). System integration failures account for many of the failures in modern buildings (Selkowitz et al. 2008, 5).

While some of the technology and practices needed to build zero-energy commercial buildings exist today, these are often expensive and limited to relatively small, simple buildings and require expertise that only a few players possess. To make large, complex zero-energy commercial buildings will require continued technology development, better access to information, institutional innovation, broad capacity-building, and significant investments. To make these buildings commonplace will require a profound transformation in how everyone works - clients, architects and engineers, construction firms, financing institutions, facilities managers and operational staffs who operate and maintain the completed buildings, and teachers who train those who work in all of these vocations.

Overview of the Zero Energy Commercial Buildings Consortium

Commercial Buildings Initiative Background

The U.S. DOE Commercial Building Initiative (CBI) convenes representatives from the private sector, national laboratories, corresponding federal agencies, and non-governmental organizations to advance energy-efficient and high-performance commercial building technologies. CBI's goal is to develop the technologies and practices to cost-effectively enable net-zero energy commercial buildings in the U.S. by 2025. Key activities of the CBI include demonstrating commercial technology solutions, supplier summits, technology identification and screening, and technology procurements.[6] The CBC coordinates its efforts with these DOE-led activities to address the overall goals set by Congress for the CBI initiative.

Commercial building energy alliances (CBEA). Commercial Building Energy Alliances bring together building owners and operators in the retail, commercial real estate, and hospital sectors,

[6] For more information on the CBI initiative see http://www1.eere.energy.gov/buildings/commercial_initiative/.

who work together towards reducing energy consumption and carbon emissions in buildings in their respective areas. Research, operating risks, facility expenses and comfort are all considered by these CBEAs. To connect member building owners and operators with suppliers, the DOE organizes a series of Supplier Summits, which provide a forum for the two sides to discuss energy efficiency challenges and solutions. Summit foci have included: 1) heating, ventilation and air conditioning, refrigeration and controls; 2) renewable energy sources; 3) lighting; and 4) building envelopes.

Commercial building partnerships (CBP). Members of these public-private partnership teams have agreed to construct one new building that uses 50 percent less energy than ASHRAE/IESNA Standard 90.1-2004 and to retrofit a building that uses 30 percent less energy than the CBECS baseline or 30 percent less energy than the mean energy intensity of their building portfolio.

Both the CBEAs and CBPs target building owners and large portfolios that can have a high and concentrated impact (Selkowitz et al. 2008, 3-4).

Role of the Zero Energy Commercial Buildings Consortium (CBC)

The CBC is a multi-year, public/private initiative focused on achieving sector-wide transformation through coordinated technology development, demonstration, and deployment supported by major innovations in policy, financing, project design and delivery, and building energy management. Industry stakeholders convened this broad-based consortium to help coordinate federal, state and local, utility, and private sector efforts and thus accelerate needed technology innovation, process change, and market transformation. The role of the CBC is to provide a bridge for the rest of the industry, including not only building owners and operators, but also design professionals, state and local governments, utilities, manufacturers, lenders, and appraisers, to articulate the questions, identify candidate technologies, and evaluate solutions needed to transform the sector. Led by a Steering Committee[7] representing prominent national industry, NGO's, and public organizations, the CBC formally launched in late 2009. The National Association of State Energy Officials (NASEO) manages the consortium. The CBC's initial tasks, to be performed by the more than 340 consortium members with funding from DOE, are to compile and review data on current and emerging technologies, systems, and practices needed for zero-energy commercial buildings, and to work with DOE to identify and address the strategies to address cost reductions and non-cost barriers to widespread market adoption of these technologies.

CBC members are encouraged to participate and build membership in the CBEAs; attend Supplier Summits; promote the Commercial Building Partnerships; contribute to the High Performance Buildings Clearinghouse; take part in DOE roadmapping activities for Zero Energy Commercial Buildings; participate in the upcoming Net Zero Energy Buildings Summit (April 2011); and provide updates and information for the biennial report to Congress (Crawley 2009).

One of the important functions of the CBC will be to help close the gap between technology development and application. On the technology assessment side, what are ways to continue to improve existing technologies and broaden their applications to increase their energy performance? At the same time, what measures and practices needed to reach zero energy do not yet exist and remain to be discovered? On the market and policy side, how can we align

[7] See the list of CBC steering committee members online at www.zeroenergycbc.org/about.php

incentives, expand awareness and know-how, and increase the chances that owners, developers, designers, and occupants can easily make energy-efficient choices and investments.

Through its broad industry-based collaborative approach, the Zero Energy CBC intends to serve as meeting place for industry stakeholders to facilitate knowledge sharing and diffusion and also to provide a feedback to the DOE on research and development (R&D) priorities and commercialization opportunities and strategies. The findings of the CBC's two main deliverables, the *Next Generation Technologies* and *Analysis of Cost and Non-cost Barriers Reports,* will inform both the DOE and the wider commercial building industry on every step of the commercialization process: from research and development to demonstration and market acceptance. The results are intended to shine a light on practical next steps and make recommendations for the future action.

The CBC complements the DOE's other initiatives (the CBEAs and CBPs) that concentrate on current and near-term technology opportunities. Taking a longer view, the CBC will focus on the transformative technologies that may not yet be economically attractive today but will be necessary to approach zero net energy. The challenge will be to improve the cost-effectiveness of technologies to the point that they can achieve the energy goals in combination with policies and incentives that are not unacceptably disruptive. However, not only is the CBC focused on the end goal of net zero energy, it is also invested in the whole path to zero and each step to achieve it. Efforts will also highlight solutions and recommendations for achieving 50%, 70%, and 80% reductions in energy use. Furthermore, the CBC recognizes that even once buildings are widely designed to be net zero, the next challenge will be to ensure buildings perform as designed. These are long-term issues that will need sustained and dedicated industry coordination for years to come, and the CBC is now building the basis for that sustained effort.

In addition to the work going on at the DOE, the CBC acknowledges that others have made extensive progress on these issues as well, and it does not intend to duplicate this work, but rather to aggregate, coordinate, and synthesize the what has already been done to advance commercial building efficiency. By keeping the CBC apprised of local, state, and regional initiatives related to high performance building in the commercial sector, CBC members play a crucial role in helping the program align and coordinate efforts with others, leveraging the industry's resources as a whole.

The CBC's broad membership is unique within the DOE Commercial Buildings Initiative and will serve as a complement to the more targeted audiences and efforts of the CBEAs and CBPs. High rates of ongoing participation in the CBC indicate the timely nature of this initiative and the high level of interest in the industry.

CBC tasks. The CBC is currently funded by DOE to: 1) compile and assess, from an industry perspective, information on performance and cost of next-generation technologies, systems, and practices to establish a knowledge base; 2) identify market potential, barriers, and strategic solutions needed to accelerate deployment and widespread use of these advanced technologies; 3) coordinate industry activities and promote information exchange with DOE commercial sector partners, other federal agencies, utility, state, and local initiatives, and the private sector; and 4) disseminate this information to guide decisions in the commercial building delivery and operations chain as well as national, regional, and local policy makers.

In the first project year, the CBC will develop two major deliverables: (1) a next-generation technologies report, and (2) an analysis of cost and non-cost barriers and policy solutions. A final analysis will be compiled by the Steering Committee from these reports.

The goals of the *Next Generation Technologies* report are to advance technologies that are not ready or economical today but are nonetheless needed to achieve zero energy buildings; characterize gaps between technical feasibility and market achievability of selected technologies; and devise and recommend ways to bridge these gaps through technology R&D priorities and other focused innovation mechanisms, under the lead of the Association of State Energy Research and Technology Transfer Institutions. Technology aside, an *Analysis of Cost and Non-cost Barriers* report, led by the New Buildings Institute, will identify and characterize market barriers; assess policies and programs to date and identify characteristics and strategies of successful programs; and make recommendations on what promising solutions and approaches may warrant additional resources or complementary policies. All of these goals and objectives are in the service of accelerating adoption and commercialization of technologies and practices that can achieve a net-zero energy transformation of the commercial building sector. The CBC's broad-based, national network is an ideal platform for assembling and equipping teams of dedicated industry stakeholders to test pilots and also to scale proven concepts.

Working group structure. Twelve working groups have been established to provide structure to and allow for efficient and coordinated communication of the membership. The groups are separated into two segments based on the CBC's main tasks: 1) Technologies and Practices, and 2) Market and Policy. The objectives of the Working Groups are to support the CBC in producing its two main deliverables.

Figure 2: 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 Appraisal
	11. Owner/Tenant Issues
	12. Workforce Development

Source: Zero Energy Commercial Building Consortium

How to get involved. Interested parties can visit the CBC website (http://zeroenergycbc.org) for more information. A membership form is available online for potential members to designate their organization's interests, expertise, and point of contact.

Active members are expected to commit time and resources in support of the tasks above by participating in one or more working groups; contributing best practices and case studies, reviewing Consortium reports, promoting the Consortium at industry events, and collaborating with other members.

Corresponding members receive regular correspondence and are recognized on the program website (www.zeroenergycbc.org). These members include those who cannot commit

to the duties of an Active Member, but still want to show support for the program and stay in touch with it. As of May 3, 2010 there were 212 active members and 128 corresponding members, totaling 340 members overall.

Conclusion

The success of the Consortium is based on each member's ability to communicate the importance of this collaborative effort to related industry organizations and participate in the input and review process. The development of a thoughtful, prioritized inventory of next generation technologies and practices, and an analysis of barriers and policy solutions are efforts that require broad input and review. Such a process fosters both credibility and a sense of ownership and engagement in the community. By successfully enlisting broad and sustained involvement, and helping to "connect the dots" among numerous other government and non-governmental programs, the Commercial Buildings Consortium will help accelerate the transformation of our long-lived capital stock, avoiding "lost opportunities" to enhance the energy performance of every commercial building and thus reduce operating costs and greenhouse gas emissions alike.

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