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Scale Matters: An Action Plan for Realizing Sector-Wide “Zero Energy” Performance Goals in Commercial Buildings

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ABSTRACT

It is widely accepted that if the United States is to reduce greenhouse gas emissions it must aggressively address energy end use in the building sector. While there have been some notable but modest successes with mandatory and voluntary programs, there have also been puzzling failures to achieve expected savings. Collectively, these programs have not yet reached the majority of the building stock, nor have they yet routinely produced very large savings in individual buildings.

Several trends that have the potential to change this are noteworthy: 1) the growing market interest in “green buildings” and “sustainable design”, 2) the major professional societies (e.g. AIA, ASHRAE) have more aggressively adopted significant improvements in energy efficiency as strategic goals, e.g. targeting “zero energy”, carbon-neutral buildings by 2030. While this vision is widely accepted as desirable, unless there are significant changes to the way buildings are routinely designed, delivered and operated, zero energy buildings will remain a niche phenomenon rather than a sector-wide reality. Toward that end, a public/private coalition including the Alliance to Save Energy, LBNL, AIA, ASHRAE, USGBC and the World Business Council for Sustainable Development (WBCSD) are developing an “action plan” for moving the U.S. commercial building sector towards zero energy performance. It addresses regional action in a national framework; integrated deployment, demonstration and R&D threads; and would focus on measurable, visible performance indicators. This paper outlines this action plan, focusing on the challenge, the key themes, and the strategies and actions leading to substantial reductions in GHG emissions by 2030.

Energy Use in Commercial Buildings: Defining the Challenge

Studying recent trends in commercial sector energy use does not provide much cause for optimism. And looking ahead, the business-as-usual scenario looks even worse - the largest projected increase in carbon emissions through 2030 will come from buildings, due to a growing population, trends for larger homes and more commercial floor space per person, and a continued shift toward the use of electricity in providing energy services, according to the Annual Energy Outlook [EIA 2007]. While the specifics in the AEO can be challenged, these trends have been observed in building sector energy use over the last 15 years.

While there have been many positive and encouraging developments at work at a smaller scale scattered within the building sector, none of these developments has yet impacted the breadth and depth of the industry in a manner that will reverse the energy use trends noted above. This is due to many factors, including the fragmented and risk averse nature of the industry, the gap between capital investments and operating savings, the confusing price signals in the market place, and the lack of a coherent national energy policy or plan. Creating buildings that use only half the energy typically used today is a challenge for most designers today but the technical potential exists to go even further. These "net zero energy" buildings (ZEB) follow the strategy of first achieving very aggressive reductions in energy use needed to provide the desired energy services, and then providing the remaining energy requirements with on-site renewable energy. These strategies have been successfully implemented in a handful of singular buildings, generally at significant additional cost [DOE Building Technologies Program 2004; Petersen 2007]. The technical pathway to achieving similar levels of performance has been studied more broadly for different building types and climates and shown to be technically achievable, although not always cost-effective, to varying degrees using technologies and practices that exist today or should be available in the near future [Griffith 2006]. That which is technically feasible, however, is not common practice. For example, while the Energy Policy Act of 2005 offers tax incentives for buildings that perform 50% better than code, the New Buildings Institute has found that only one in one thousand new buildings meets the EPACT 50% reduction standard [NBI 2007]. This serves as a sobering reminder of the pragmatic difficulty of realizing achievable performance goals throughout the nation's building stock.

However challenging this may be, the difficulty of routinely creating buildings that cost-effectively meet ZEB performance levels is only exceeded by the importance of doing so. Climate scientists argue that the developed world ought to reduce absolute carbon emissions by 50% or more to allow developing countries some access to increased energy use to improve their lifestyles and evolve rapidly to efficient solutions for their growing building stock [Stern 2007]. Shifting the U.S. commercial building stock from its current energy appetite of 18 Quads at an annual cost of $160B to a footprint roughly half that size over the next 20 years is a formidable challenge. While many actions are underway to reduce energy use in the commercial sector, there are none that are systematically, aggressively, and convincingly targeted at designing, implementing and executing a national program to achieve these very aggressive goals.

To help address this need, the framework for a Zero Energy Commercial Buildings Initiative (CBI) was created in a series of meetings involving the leadership of AIA, ASHRAE, USGBC, and participants from a wide range of other interested parties. The goal of this public-private partnership is 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. This has been compared to a challenge similar to that of putting a man on the moon. In fact it is more difficult because the Apollo program had a very challenging but clear technical goal executed by a large but well-defined, well funded and well organized engineering team. The buildings challenge may more appropriately be compared to the broad challenge to eradicate polio. This required a large, multiyear effort with a significant underlying technical effort to develop a workable vaccine, in addition to the development of an implementation and deployment infrastructure with advocacy programs reaching ever corner of the country, impacting economic and social systems and touching the lives of many Americans. Programs of this sort are in many ways more difficult to design, implement and manage than those dominated by technical challenges alone. But if we are to successfully address the climate change challenge there is no greater need in the U.S. today.

We summarize in the next section some of the guiding themes that emerged from discussions and interviews with key stakeholders over the last year in formulating this initiative and action plan. These interactions with stakeholders took many different forms and provided diverse, yet generally consistent outcomes. Initially an extensive review of past studies was completed and discussions were then held with members of key industry stakeholders to confirm that there was a need for such an activity and to identify any existing efforts of this type and scope. There was surprising unanimity that despite the high level of interest in zero energy buildings there was no effective national effort of the scope and scale needed to effectively reach commonly held goals. Building on this background effort, a small day-long workshop in October, 2006 laid the groundwork for the Initiative. A series of structured interviews was held with industry thought leaders. Two additional larger workshops, one with breakout sessions organized by sectors, further developed insights that were used to develop the action plan. These workshops were attended by researchers, owners, industry design professionals, trade organizations, and policy experts from the retail, office, and government/institutional sectors of the commercial buildings marketplace. Contacts were also made with a variety of international activities targeting similar outcomes to explore their approaches and actions.

Premises and Themes

The assessment process described above generated a large body of input materials from which a number of unifying themes were extracted and synthesized. We describe below some of these guiding themes that emerged from discussions and interviews with key industry stakeholders and discuss briefly the implications for strategy and actions..

Achieving very demanding energy performance goals will require an aggressive, dedicated, long-term cooperative effort on the part of many stakeholders. Progress toward the long term goals will be made incrementally in measured stages so it is essential to develop a commitment and plan with appropriate resources for a sustained effort. These goals can only be achieved if the CBI reaches a large number of stakeholders and decision makers across the building supply chain and life cycle.

The CBI effort must address the four key elements or business forces needed to transform the commercial sector: Policy, Finance, Process, and Technology. Energy policy begins at a national level but often will have important drivers at regional, state and municipal levels. Financial impacts are influenced by market forces at all scales and by the owner/investor decision criteria. The process by which buildings are designed, constructed and operated provides many opportunities but even more potential obstacles on the path to achieving the CBI goals. Technology can be a limiting or enabling element in reaching performance goals. These four business forces rarely operate alone – more typically two or more interact at any given decision point, with both positive and negative outcomes with respect to CBI goals.

Building owners are the key to progress and success. They make the initial critical decisions regarding project performance goals, they select the design team to develop a design solution that will meet performance goals, and they must ultimately provide the finances to execute the final design. Once the building is operational they must sustain the effort to ensure that performance goals are reliably met. Their perspectives are shaped strongly by their business context and the practices of the commercial sector in which they operate. They are a very diverse group but they are critical stakeholders who must be engaged throughout this activity.

Aggressive national goals must be framed by an effort that is planned and coordinated nationally, but must operate with a primary locally-based implementation effort. While the broader economic and business trends are national and much of our energy policy is enacted at a national level, local markets drive the specifics of commercial sector investment. Major equipment and system suppliers are typically focused on national markets but recognize that with most customers sales occur on a decentralized basis (national chains are an exception). Most buildings are occupied and leased primarily on a local and regional basis, designers and contractors are often locally or regionally based, and installation and service has a strong regional component. Thus, the ultimate business market that we need to transform has both important national and local elements, all of which CBI must address.

The commercial stock is diverse in terms of building type and size, ownership and investment parameters (e.g., owner occupied vs. speculative development), and requires strategies and actions that recognize that diversity for both new and existing buildings. The CBI recognizes these important differences and creates programs that accommodate the varied needs of each market sector, building on the new national alliances launched by DOE in FY2008. The primary CBI thrust is a "sector-based" approach, recognizing the importance of the differing views of the "business case" as seen by stakeholders in each sector. It addresses both new and existing buildings since the end goal is aggressive reductions in overall sector energy use. For a program with a short term goal the focus would logically be on existing buildings. However, CBI's longer (25-year) time frame argues that aggressive attention should be paid to new buildings as well; at current construction and renovation rates, roughly 2/3 of the buildings in 2030 will be either new since 2007 or renovated. Our existing building stock can become a test-bed for strategies that can be implemented in both new and existing buildings.

Target large portfolios with replicable, extensible strategies: While the specific operational goals of CBI are still under development, its overall goal is to reach and reduce the largest possible fraction of commercial sector energy use. The U.S. commercial sector contains about 4.8 million buildings occupying 71 billion sf, indicating that the average building is very small, about 14,000 sf. But the relatively small number of large buildings constitutes a very large fraction of the total building area and therefore the total energy use. In fact the largest 5% of buildings by numbers (about 50,000 sf and above) makes up about 50% of the total building area and energy use. Therefore an approach that targets large buildings and their owners may tactically be the most effective strategy to have the largest energy impact with limited resources.

Define clear performance goals for net zero energy buildings. There are a number of definitions of zero energy buildings in common use today, which involve complex decisions regarding site and source energy, gas vs electricity, etc. We adopt a general description as follows based on energy measured at the building site: a net zero energy building is characterized by a substantial reduction in the intrinsic energy needs of the building, typically 60-90% less than current practice for that type and region, allowing the remaining required energy to be supplied more cost effectively by renewables.

The leap from current practice to net zero energy will not be made in on one bound but rather in a series of incremental stages. The effort will require major change along two independent axes - increasing the depth of savings in each building, and increasing the breadth of the market that is impacted. The size, scope and timing of these changes will vary with market sectors and climate as well as other factors. We have organized the process along four performance increments:

- Business as usual = just meeting the building code
- 0 - 30% improvement beyond current practice (e.g. ASHRAE, USGBC and others are developing Standard 189 that is intended to become a new reference base for

green building design, tightening energy use by approximately 30% beyond current codes.)

- Best practice = 30-50% better than current practice
- Net Zero Energy = 60-90% better than practice with renewables contribution added to reach Net Zero levels.

Getting to net zero energy becomes more difficult as one gets closer to the final goal. The four stages above are not of equal difficulty. Saving the first 30% ought to be readily and cost effectively achievable in most buildings. As one moves toward zero net energy the problems become very much more challenging.

There will be new job opportunities for people with enhanced technical skills to design, construct and operate zero energy buildings. In an era when many jobs are being lost to overseas outsourcing there is an opportunity here to create a massive number of skilled, high paying technical jobs in these areas if the appropriate training and certification programs can be established.

The effort to dramatically reduce energy and carbon should build on and leverage other ongoing industry transformations that are not specifically energy-related. While there are many such transitions underway in the building sector, two notable and rapidly evolving aspects deserve particular attention.

- The broad and growing movement toward sustainable design and green buildings.
- A growing industry-based movement toward the adoption and use of Building Information Models (BIM)[1].

Make the business case for Benefits of Zero Energy Buildings: The costs and risks of net zero energy, high performance buildings are at least partially understood; the benefits are not as well documented. They fall into several categories:

- Energy savings leading directly to economic benefits - these are the most readily understood and documented.
- Increase in net asset value from documented energy savings and potential maintenance savings from good building systems operations.
- Non-Energy benefits that increase market value and net asset value, e.g., view and comfort. Much more scientific work will be needed in some of these areas to properly document the impacts on health and productivity.

Leverage the role of technology innovation: The potentials for technology innovation are often either overemphasized or underappreciated in the movement toward zero energy buildings. Obstacles to lack of use of existing advanced technology are higher cost, lack of understanding of how to integrate the technology into a working system, and inability to guarantee performance once installed. Many of the failures in modern buildings are system integration failures. Better system platform design, plug and play configuring systems, feedback sensors as part of self commissioning systems, and auto diagnostic software and hardware all are examples where R&D to redesign and/or improve technology could have a major impact.

Making performance visible: One of the biggest performance issues in buildings is the operational gap between designed or "intended performance" and actual performance. There is a

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[1] A Building Information Model is a data model that contains building geometries, spatial relationships, and properties of all components and systems. Systems, assemblies, and sequences can be represented according to their relative scale and interrelationships, and the complete models can be used not only in design but to facilitate construction and operation processes throughout the building life cycle.

growing interest in converting building energy management systems into more useful, actionable information dashboards that will properly inform and motivate the facilities operators to do better job of achieving expected performance.

Why don't we routinely create zero energy buildings today? A proper answer will acknowledge that the details vary with the complex interaction of factors such as climate, building type, designer, and owner. A simpler answer is that:

1. Owners don't know to properly specify the needed performance parameters and are not used to paying more upfront costs. In addition, they are often concerned about the risk inherent in use of new approaches.
2. Designers view the buildings as too complex to reliably design, and many have neither the experience nor the tools to do the job effectively.
3. The technologies and integrated systems needed for many designs are not easy to find at affordable cost and are challenging to incorporate into a design in a manner that will work reliably.
4. The designs, components and systems may not be referenced and accepted by code officials.
5. Components and systems are harder to install and commission, often by contractors who have no experience with them.
6. Building occupants do not understand how to use or maintain ZEB equipment and systems.
7. Since energy use is not normally tracked there is no indication of the performance of the building over time.

In the simplest terms we don't create Zero Energy buildings today because decision-making in the risk-averse commercial sector is heavily driven by short term financial considerations. There is not (yet) a compelling financial argument for ZEB at current energy/carbon costs, nor is there a strong business case that addresses the seven barriers described above. These obstacles and barriers are challenging but surmountable if they are understood and if the resources to address them can be applied to each issue. The CBI action plan is designed to do that.

Strategies and Actions

The strategies and actions in the Action Plan were determined through interviews with industry leaders in efficient building development, a broad literature review, and a workshop for key stakeholders. For purposes of the Action Plan and this paper we defined the strategies in 8 sets, each with an underlying set of actions. In the "real world" multiple strategies and actions are often tightly coupled in a manner that enhances their impact but complicates the ability to easily describe them. Some of these interrelationships are noted below but many more will apply in any given commercial sector activity and program. In this section, we provide a summary of the eight strategies:

Strategy #1: Integrated design, construction and operations
Strategy #2: Financial instruments, valuation and performance-based compensation
Strategy #3: Incentives: tax and utility programs
Strategy #4: Benchmarking and Labeling
Strategy #5: Codes and standards
Strategy #6: Owner-driven alliances for procurement and specifications

Strategy #7: Education, training, certification and technical assistance
Strategy #8: RDD&D for new components and systems

For each strategy, its rationale and associated actions are reviewed. Detailed descriptions of the action impacts and prior and current activity, the literature review, interviews, and workshop findings are provided in the Action Plan [CBI 2008].

Strategy #1: Integrated design, construction and operations

Building integration has been a mantra that is dutifully recited by everyone when discussing energy efficiency and sustainabilty. While there have been many efforts toward this end, it is still far from standard practice. CBI will need to:

- Develop and disseminate processes and tools to link design, construction and operation to assure building performance;
- Identify barriers to cost-efficient design, construction and operation of high performance buildings;
- Develop and deploy processes and standard procedures;
- Develop and deploy design tools, simulation, BIM, interoperability, functional testing, performance monitoring, benchmarking and automated diagnostics;
- Transform the process of delivering and operating buildings so that design intent is realized and operating performance closely approaches technical potential on a routine basis.

This is a diverse strategy with varied actions, and should be started immediately.

<u>Actions:</u> The actions for this strategy are categorized by their relationship to barriers and rewards, software and tools, or feedback and diagnostics.

Barriers and Rewards:

1. Identify the barriers to the effective delivery and operation of high performance buildings and define pathways to remove these barriers.
2. Remove barriers to collaboration in professional practice.
3. Remove building code barriers to collaboration.
4. Work with unions and contractors to reduce installation barriers.
5. Establish fee structures that reward the design team for extra risks and effort.
6. Shift responsibilities from equipment to systems and the whole building.
7. Disseminate case studies that demonstrate the benefits of integrated design.

Software and Tools:

8. Assess need for new software tools to support collaborative work processes for building design.
9. Improve and promote software interoperability and BIM support for integrated design construction and operations.
10. Develop and deploy validated analysis tools that can optimize the design and operation of current and emerging systems.
11. Develop and deploy extensible analysis tools to support innovative design.

Feedback and Diagnostics:

12. Design standard protocols for post-occupancy evaluation.
13. Promote the use of performance monitoring and action-oriented benchmarking.

14. Develop and deploy automated diagnostic tools for functional testing and for routine operation.
15. Develop and deploy improved tools and industry standards for commissioning and retro-commissioning.

Strategy #2: Financial instruments, valuation and performance-based compensation

The impact of financing on the commercial building marketplace cannot be overstated, and there are many aspects of commercial buildings finance that could be improved upon to encourage higher performance. Financiers are commonly bound by fiduciary obligations that do not include considerations of energy, so that there remains a growing need to link the benefits of high performance buildings to financial models and a deeper understanding of business and market needs [USGBC Research Committee 2007]. The goals of this strategy are to identify market criteria and develop and deploy methods and tools to value enhanced performance and to reduce the risks associated with buying, selling and underwriting high performance buildings. In addition, the strategy seeks to develop and deploy methods and tools to extend performance contracting to new construction and major retrofits.

The topical similarity with Strategy 3, tax and utility incentives, suggests that the two strategies would best be developed in parallel.

Actions:

1. Include building performance in real-estate valuation.
2. Develop and promote alternative leasing provisions that address split incentives.
3. Accelerate the deployment of life-cycle cost analysis (LCCA) tools.
4. Extend performance contracting to new construction and major retrofits.
5. Provide commercial building mortgage-backed securities in investment banking.
6. Produce and disseminate case studies on how the market values sustainable buildings.

Strategy #3: Incentives: tax and utility programs

There is a wide and growing array of tax incentives and utility programs for energy efficiency. This strategy builds on this foundation to identify and implement a comprehensive, integrated set of incentives and other programs to supplement conventional energy price signals. Here, the vision is to facilitate a market transition such that high performance buildings and efficient operation are the norm. In the context of this strategy, incentives include federal, state and local tax credits and deductions, a wide variety of utility financial and technical assistance programs, and accelerated permitting.

Actions:

1. Develop and expand utility programs and incentives; reward higher performance.
2. Decouple sales and revenues for utilities nation-wide.
3. Develop and expand tax credits for high performance buildings.
4. Develop programs for capital subsidies, grants, and loans.
5. Promote expedited permitting for high performance buildings.

Strategy #4: Benchmarking and Labeling

Measuring and disclosing real performance consistently and reliably across the commercial building sector is essential to stimulate market awareness and demand for improved energy performance. However, there is a significant and persistent lack of measured data on the actual energy performance of buildings. Accordingly, this strategy involves the development of:

- Policies that encourage or require investment grade disclosures and labeling of real performance, such as the Energy Performance of Buildings Directive in the European Union. Policy development would be driven by public and private sector owners, to create market pull for performance disclosures.
- Rigorous and standardized procedures to measure, calibrate, and publish performance data, in order to ensure credibility with investment decision-makers, and consistency across the building sector.
- Tools to aid performance assessment and benchmarking. Over the past 10 years there has been considerable work in this arena - most notably in the EnergyStar program. However, the current suite of tools needs further development to improve their applicability and usability for investment-grade disclosures on energy performance, and to ultimately provide disaggregated end use performance data.

This strategy can deliver results in the near term through wider deployment of existing benchmarking and labeling tools, especially by combining incentives and mandatory approaches. While there have been important efforts underway, more powerful databases and tools are necessary. Since benchmarking provides a highly reductive summative rating of building performance, it has an important role in developing financing instruments and building valuation (Strategy 2), as well as in tax incentives and utility programs (Strategy 3). Benchmarks may also be incorporated into codes and standards (Strategy 5).

Actions:

Policies:

1. Mandate energy and carbon labeling.
2. Implement benchmark-driven codes and incentives.

Procedures:

3. Standardize metrics/definitions for commercial building performance.
4. Develop a shared understanding of how labeling and behavioral strategies can reduce energy consumption.

Tools:

5. Expand existing benchmarking databases and tools.
6. Develop "action-oriented" benchmarking tools and protocols.
7. Expand and integrate cases study databases for high performance buildings.

Strategy #5: Codes and standards

Codes and standards have proven to be a cost-effective, successful means of ensuring gradual, significant improvements in energy performance [DOE State Energy Alternatives 2006]. A 2002 study showed that codes and standards programs cost 2-6% the cost of efficiency programs [Stone 2002]. The American Council for an Energy Efficient Economy has estimated that code-based improvements in health and productivity alone amount to $170 billion savings annually [DOE State Energy Alternatives 2006]. Recent updates in California standards have saved approximately 1081 GWh as of 2007 [Stone 2002], and estimates show that in less-regulated regions such as the Southwest, a historically less-aggressive region, savings of over 50% above base case structures can be garnered [Kinney 2003]. Effective enforcement and compliance is necessary to ensure the effectiveness of any codes and standards program. These responsibilities traditionally fall under the authority of local governments. However, locating the resources and knowledge to enforce mandatory codes is often prohibitive [Smith 1995]; mandatory codes are often bypassed due to complexity, and many states rely on voluntary programs for compliance [DOE State Energy Alternatives 2006].

This strategy represents a standard, historically successful, and straightforward means of requiring the delivery of minimum of higher-performing buildings. It can be implemented over a continuous time-scale using incremental increases in stringency. Moreover, successful approaches from different regions and sectors provide a convenient informed starting point for development and implementation.

Actions: The actions associated with this strategy are divided into short-term and long-term activities.

Short-term:

1. Offer government, state, or utility programs to assist and verify compliance.
2. Lower the threshold at which standards apply to renovations and expansion
3. Revise LEED for increased importance on Energy and Atmosphere credits.
4. Increase LEED requirements for public and new buildings of certain sizes.

Long-term:

5. Increase stringency of mandatory codes and requirements for efficiency.
6. Require efficiency and benchmarking and disclosure of results.
7. Require buildings to retrofit at resale, lease renewal, or by a given date.
8. Require submetering for all tenants in commercial buildings.
9. Require self-diagnostic EMS with data management for new buildings.
10. Assess compliance based on actual performance rather than design.

Strategy #6: Owner-driven alliances for procurement and specifications

Energy efficiency requirements are not properly integrated with specifications and procurement processes, resulting in missed opportunities to meaningfully transform the market for energy efficient products. Manufacturers have little incentive to invest in product improvements for uncertain market returns. The purchasing power of owners, aggregated by market sector and coordinated for maximum impact, can correct some of these market “imperfections”. Buy-down approaches, government procurement procedures, linking manufacturing and efficiency efforts in product development and specifications, and programs to facilitate the purchased of bundled efficiency options have shown promise in a variety of projects [Duncan 2006; Harris 2004; Khan 2006].

This strategy is closely related to others dedicated to integrated design construction and operations, benchmarking, and codes and standards, all based around the needs and market pull of specific commercial sectors.

Actions:

1. Form national energy alliances for specific subsectors.
2. Link efficiency and manufacturing communities in the development of specifications.
3. Implement buy-down programs for manufacturers to offer lower prices.
4. Expand and promote existing government procurement processes.
5. Motivate industry leaders to adopt procurement processes analogous to those of government.

Strategy #7: Education, training, certification and technical assistance

It is widely acknowledged that there is a need for increased knowledge and skill in the design, delivery and operation of energy efficient buildings [Green Building Initiative Task Force 2004; NBI 2007]. In the current marketplace, many stakeholders are unaware of proven existing methods, while others may have an interest in energy efficiency yet lack the ability to implement effective measures. Construction, commissioning and operations of more efficient buildings often requires skill sets that are not yet widely available. In response, this strategy aims to: improve and expand treatment of building energy issues in all K-12, 2-year and 4-year undergraduate programs, vastly expand the professional architectural and engineering educational and training programs; expand trained commissioning infrastructure, engage employers to locate certified professionals; expand technical assistance programs; and implement programs to facilitate/support integrated design for specific projects or firms.

Actions:

1. Develop expanded, robust training programs for existing design professionals, contractors, commissioning agents, etc..
2. Simplify locating qualified personnel by promoting existing accreditation and certification programs.
3. Develop a multi-week post-graduate institute for high performance buildings.
4. Enhance college curricula in engineering and architecture.
5. Develop an approach to advance the practice of integrated design.

Strategy #8: RDD&D for new components and systems

The ambitious CBI long term goals will necessarily require increased support for research, development, demonstration, and deployment of new technologies and solution packages that deliver much higher performance levels in cost effective packages. An emphasis on a systems-oriented approach to climate-appropriate design will increase the effectiveness of the technologies developed [Levine 2007; NBI 2007].

Planning approach:

- Use stock modeling tools, technology diffusion and scenario analyses to identify promising new technologies – components, systems and system integration – to reduce the energy end uses in different building types and climates. The technologies identified will enable reductions to an extent that long-term energy and carbon goals for the sector can be achieved.
- Identify additional opportunities where RD&D can accelerate market adoption of existing underutilized high performance systems by reducing risk and lowering costs.

- Identify the appropriate combinations of public and private effort and funding for each phase of the necessary research, development, demonstration and deployment and set priorities for public funding to complement, leverage and accelerate private investment.
- Facilitate the formation of public/private consortia, and international collaboration where appropriate, to pursue high priority programs and projects.

The action plan lists a number of specific technologies as well as integrated systems in HVAC, lighting, envelope, refrigeration, on-site generation, controls and plug loads. The specific development path for each of these will be determined using the above planning approach.

Summary and Next Steps

The framework, approach, strategies and actions described in the CBI Action Plan represent a starting point for the Initiative. There are several types of challenges for such an initiative in moving forward.

The first two focus on scope, scale, detail and management: 1) moving from a general overview and framework to a more detailed action plan and roadmap with specific, prioritized and funded activity, and 2) coordinating and managing an intrinsically decentralized activity that is national in scale, with hundreds of collaborators, and with goals that are years in the future. The plan does not yet address these issues in detail- but the next steps require that this level of detail be developed. Those steps need to be taken by a larger and broader group than has worked on this plan to date, and with associated resources to undertake planning at this level of required detail.

A companion challenge is one of defining, building and expanding a stakeholder base for this activity. Zero energy buildings have captured the “attention” of a small, but growing, subset of the commercial building sector as a 2030 future vision, but only a small minority of these advocates are themselves directly engaged in actions leading to that goal. We choose to view this glass as half full- and the challenge for CBI is to build and leverage that initial interest into a coherent, mainstream national program that can accomplish its goals. This is unquestionably a very difficult challenge, sitting at the intersection of finance, policy, technology, and markets within the commercial sector. But action in this area is likely to be facilitated by changing public perceptions and a growing global concern for the impact of our buildings and lifestyle on energy and climate.

Next Steps: “Planning by Doing” - In parallel with addressing these larger strategic issues, we have begun to explore how to move the action plan into the next phase of refinement and development. Each of the strategies and actions outlined above merits more extensive planning, with a particular focus on applicability to specific commercial sectors, time frame for action and priority. However, more planning activity in and of itself is not sufficient to move the initiative forward. Therefore, we propose the next phase involve “planning by doing,” i.e., planning activity coupled with actions that yield early results, build momentum, and inform the planning activity. Accordingly, the next phase might involve the following activities:

1. <u>Start opportunistically on selected strategies and actions</u>
   The intent here is to get started on selected actions somewhat opportunistically, based on existing stakeholder organizations and motivation, potential for early results, funding and

cost-share, etc. Existing stakeholder groups could begin to develop detailed implementation plans for selected strategies and actions. For example:

- The Green Building Finance Consortium could "adopt" strategy #2 (Innovative financing);
- The International Code Council could adopt strategy #5 (codes and standards).

The implementation plan would describe specifics of tasks, schedules, budgets, sequencing, etc. A steering committee would help coordinate cross-cutting activity.

2. Set up a mechanism for monitoring and reporting the "state of the sector"
   This would involve the following steps:
   - Build a stock model for overall energy and carbon metrics
   - Identify energy and non-energy metrics (e.g. # trained professionals, technicians, etc.)
   - Set up monitoring mechanisms – data sources, databases, etc.
   - Set up reporting mechanism – compilation, review process, etc.
   - Disseminate and publicize the "state-of-the-sector" via web, reports, etc.
3. Pilot Projects – "role play" the future
   The intent here is to take existing buildings or design projects and use them as the basis of "experiments" to explore outcomes under different technological, financial, process, and policy environments.
   - For example, take selected buildings in the DOE High Performance Building database and explore what might have happened under different scenarios.
   - Similarly, for design projects, set up a parallel "shadow" project that has the same players (designers, financiers, owners, etc.) operating in a different "reality" in terms of technology options, financing mechanisms, codes, policies, tools, etc. The outcomes would be analyzed and inform the effectiveness of different actions.

We believe that activities such as these outlined above and others to be defined will provide useful short-term output that facilitates and refines both the overall Initiative plans and goals, and further develops shared stakeholder interest in this activity.

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References

Commercial Buildings Initiative. Draft Action Plan. 2008. Draft available from authors.

DOE EERE. High Performance Buildings Database. Building Technologies Program: Building Database. DOE EERE; August 31 2004. Available from:http://www.eere.energy.gov/buildings/database/.

DOE EERE. State Energy Alternatives: Energy Codes and Standards; August 30, 2006. Available from: http://www.eere.energy.gov/states/alternatives/codes_standards.cfm.

Duncan T., D. Ferington, M. Sanders, K. Keating. 2006. "Savings with a twist: a market transformation and acquisition working together (and showing both)." In *Proceedings of the 2006 ACEEE Summer Study on Energy Efficiency in Buildings*. Washington, DC: American Council for an Energy-Efficiency Economy.

Energy Information Administration. 2007. *Annual Energy Outlook 2007 with Projections to 2030*. Washington, DC: US Department of Energy. Available from: http://tonto.eia.doe.gov/ftproot/forecasting/0383(2007).pdf.

Green Building Initiative Task Force. 2004. *Green Building Action Plan, Back-up Technical Document - Rationale, Specific Actions, and Timeline*. California Energy Commission; Sacramento, CA: California EPA. Available from: http://www.energy.ca.gov/greenbuilding/ab2160/documents/resource_docs/GBI_RATIONALE_ACTIONS_TIMELINE_2004-09.PDF.

Griffith B, Torcellini P, Long H, Crawley D, Ryan J. 2006. "Assessment of the technical potential for achieving zero-energy commercial buildings." In *Proceedings of the 2006 ACEEE Summer Study on Energy Efficiency in Buildings*. Washington, DC: American Council for an Energy-Efficient Economy.

Harris, J., M. Brown, J. Deakin, S. Jurovics, A. Khan, E. Wisniewski, et al. 2004. "Energy efficient purchasing by state and local government: triggering a landslide down the slippery slope to market transformation." In *Proceedings of the 2004 ACEEE Summer Study on Energy Efficiency in Buildings*. Washington, DC: American Council for an Energy-Efficient Economy.

Khan, A., T. Jones, S. Loucks, R. Cartwright, S. Andrews, M. Bramfitt. 2006. "Cooking up a new approach for commercial program design." In *Proceedings of the 2006 ACEEE Summer Study on Energy Efficiency in Buildings*. Washington, DC: American Council for an Energy-Efficient Economy.

Kinney, L., H. Geller, M. Ruzzin. 2003. *Increasing Energy Efficiency in New Buildings in the Southwest: Energy Codes and Best Practices*. Southwest Energy Efficiency Project.

Levine, M., D. Ürge-Vorsatz, K. Blok, L. Geng, D. Harvey, S. Lang, et al. 2007. *Residential and Commercial Buildings.* In Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Metz B., Davidson O.R., Bosch P.R., Dave R., Meyer L.A., editors. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

New Buildings Institute. 2007. *Getting to Fifty Symposium Summary*. White Salmon, WA: New Buildings Institute. Available at: http://www.newbuildings.org/gtf/documents/GT50_Summit_Final_Report.pdf.

Smith L., S. Nadel. "Energy code compliance."1995. Washington, DC: American Council for an Energy-Efficient Economy.

Petersen, J.E. 2007. "Production and consumption of electricity in Oberlin College's Lewis

Center for Environmental Studies: realizing the goal of a net zero building." In *Proceedings of the Solar Energy Society*. Boulder, Colorado: American Solar Energy Socitey.

Stern, N. 2007. Stern Review report on the economics of climate change. Pre-publication edition. HM Treasury;2007. Available from http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/stern_review_report.cfm.

Stone, N., D. Mahone, P. Eilert, G. Fernstrom. 2002. "What's a utility codes and standards program worth anyway?" In *Proceedings of the 2002 ACEEE Summer Study on Energy Efficiency in Buildings*. Washington, DC: American Council for an Energy-Efficient Economy.

USGBC Research Committee. 2007. *A National Green Building Research Agenda*. Washington, DC: US Green Building Council. Available from: http://www.usgbc.org/ShowFile.aspx?DocumentID=3402.