Date: June 12, 2009
To: Building Technology Research and Development Subcommittee, National Science and Technology Council (NSTC), Office of Science and Technology Policy (OSTP)
From: Mark Halverson and Paul Domich, CIP-Consulting
RE: Review of and Comparison of Recommendation of "Energy Efficiency in Buildings – Transforming the Market" to BTRD Federal R&D Agenda

Summary

The World Business Council for Sustainable Development's (WBCSD) Energy Efficiency in Buildings working group has recently released their final report, entitled "Energy Efficiency in Buildings – Transforming the Market," calling for a transformational, rather than incremental, approach to improving energy efficiency in buildings. The conclusion they reach it that an incremental approach to energy efficiency will not achieve the desired reductions in energy usage and carbon footprints necessary to achieve truly sustainable development. They also conclude the market forces, even with the addition of significant incremental carbon taxes, will not be adequate in achieving the level of savings necessary (which the report identifies as a reduction in energy use of 77% for the entire building sector).

The report calls for a number of measures that reinforce the recommendations in the *Federal Research and Development Agenda for Net-Zero Energy, High-Performance Green Buildings* (Federal R&D Agenda). The measures recommended in *Transforming the Marketplace* focus almost entirely on energy efficiency during the operational phase of the building life cycle and therefore do address a number of areas found in the Federal R&D Agenda. The measures recommended do reinforce the Federal R&D Agenda's discussions as shown below in Table 1.

Table 1. Summary Comparison of Recommendations

WBCSD Transforming the Market	**BTRD Federal R&D Agenda**
1) Strengthen codes and labeling for increased transparency	R&D Focus Area 6b – Develop tools and guides that enable the use of modern, adaptive performance-based building codes R&D Focus Area 6c – Research and develop effective incentives for adopting and using innovative technologies and practices addresses the need to develop market-based building valuation metrics and tools
2) Incentivize energy-efficient investments	R&D Focus Area 6c – Research and develop effective incentives for adopting and using innovative technologies and practices addresses the need to provide analysis of financial and regulatory incentives R&D Focus Area 2c – Develop supply-side technologies that, when coupled with energy efficiency, can achieve net-zero energy buildings and communities
3) Encourage integrated design approaches and innovations	R&D Focus Area 1b – Enable widespread adoption of high performance goals by developing practical tools and processes to address the complex interactions of building components and systems throughout the building life cycle R&D Focus Area 6a – Develop high-performance building design tools and guidance for urban planners, architects, engineers, contractors, and owner/operators
4) Develop and use advanced technology to enable energy-saving behaviors	Goal 2: Develop net-zero energy building technologies and strategies
5) Develop workforce capacity for energy saving	R&D Focus Area 6a – Develop high-performance building design tools and guidance for urban planners, architects, engineers, contractors, and owner/operators
6) Mobilize for an energy aware culture	Chapter 7 -Collection, Analysis, and Dissemination of Research Results

The WBSCD report is focused primarily on implementation while the scope of the BTRD committee is limited to R&D. These are two different policy approaches with a similar goal. As such, while there is significant resonance between the recommendations in these reports, the market approach to implementing those approaches is by design different. The recommendations are complementary and mutually supportive. There is a one to one correspondence between the WBSCD recommendation #4 (Develop and use advanced technology to enable energy-saving behaviors) and the BTRD Goal 2 (Develop net-zero energy building technologies and strategies).

There are also several concepts and recommend approaches to the building marketplace expressed in *Transforming the Marketplace* that are not covered in the Federal R&D Agenda. The scope of the WBCSD report was not focused on R&D, and as such one would expect differences in recommendations. The additional WBSCD concepts are:

1) Specific mention of building labeling
2) Periodic building energy inspections
3) Specific mention of utility barriers to implementation
4) Incentivizing integrated design
5) The need for residential retrofit “system integrators”

Background

The World Business Council on Sustainable Development's[1] (WBCSD) Energy Efficiency in Buildings (EEB) working group[2] has recently released their third and final document in their 4 year study of energy efficiency in buildings.[3] This document, entitled *Transforming the Market*[4], makes a strong case for a transformational, rather than incremental, approach to energy efficiency in buildings. Based on previous reports by the WBCSD, a target of 77% reduction in energy use and carbon footprints was set. Based on the analysis discussed in their report[5], the WBCSD EEB working group reached the following conclusions:

Conclusion 1: At energy prices proportionate to oil at US$ 60 per barrel, building energy efficiency investments in the six markets studied, totaling US $150 billion annually, will reduce related energy use and carbon footprints by 40% with five year discounted paybacks.

Conclusion 2: A further *investment*[6] of US$ 150 billion with paybacks between five and ten years will add 12 percentage points (52%). Additional investments to achieve the 77% target will not be justifiable on economic return grounds at today's energy prices and will require the additional steps outlined in this report

Conclusion 3: increasing the price of energy or carbon will only slightly increase the implementation of energy-efficient options - Reductions would only marginally increase from 52% at today's energy prices to 55% with an incremental carbon cost of US $40/ton.

Based on these conclusions, the WBCSD's EEB Working Group believes that the necessary progress will not be achieved purely through the market. Market forces will need to be supplemented by effective regulatory environments and fundamental behavior change (which may be low or no cost). This is a sobering conclusion from a group of large manufacturing and industrial organizations that might be expected to champion the power of the marketplace.[7]

Crosswalk with the *Federal Research and Development Agenda for Net-Zero Energy, High-Performance Green Buildings*

This report looks at the interconnections between the WBCSD EEB report and recent Federal R&D planning activities for net-zero energy, high-performance green buildings. The focus of both *Energy Efficiency in Buildings – Transforming the Market* and the *Federal Research and Development Agenda for Net-Zero Energy, High-Performance Green Buildings* (Federal R&D Agenda) is the need for action in creating better buildings. The WBCSD EEB report is focused more on immediate actions that should be taken, while the Federal R&D Agenda focuses on research and development that will be necessary to pave the way for some actions. However, some of actions proposed in the WBCSD EEB report are closely tied to items in the Federal R&D agenda. The WBCSD EEB report also provides another set of eyes looking at the same issues as the Federal interagency working group, and may provide alternate perspectives on the underlying issue.

---

[1] See an overview of the WBCSD in Appendix A.

[2] See an overview of the WBCSD Energy Efficiency in Buildings working group in Appendix B. Also see a listing of the core members of the working group and quotes from their corporate websites in Appendix C.

[3] See the complete list of publications from the WBCSD EEB website in Appendix D.

[4] www.wbcsd.org/web/eeb, http://www.wbcsd.org/includes/getTarget.asp?type=d&id=MzQyMDU

[5] See a more detailed outline of the WBCSD EEB report in Appendix E

[6] The nature of the investment is not defined in the report but may be presumed to be the incremental cost of the technology required to generate the efficiency savings.

[7] See a listing of the core WBCSD EEB working group members and quotes from their corporate websites in Appendix C.

The WBCSD report is focused solely on energy efficiency in buildings. The report specifically states "The EEB project has focused on energy use so we have not covered the many other important aspects of sustainable building. The energy implications of transport, water use and food choices can be as important as the direct energy savings in buildings, but they are beyond the scope of this project."[8] The WBCSD report notes that these areas (and others) are covered in other WBCSD reports. The WBCSD report also focuses on energy used during building operation, which the report estimates to be about 80% of the energy used in the building life cycle. Thus the WBCSD report does not address energy in construction or demolition. The correlation between the WBCSD report and the Federal R&D Agenda is mostly in the areas of Integrated Performance-Based Design, Construction and Operation (Goal 1) and Net-Zero Energy Building Technologies and Strategies (Goal 2). There is also a significant discussion of barriers in the WBCSD report that can be compared to the Overcoming Barriers to Implementation (Goal 6) in the Federal R&D Agenda.

At the highest level, the WBCSD report lists 6 recommendations as shown below in Table 2. The first column lists the recommendation. The second column provides a brief discussion of how this recommendation compares with the Federal R&D Agenda. In general, the correlation between the recommendation of the WBCSD report and various sections of the Federal R&D Agenda is good. The WBCSD report is not limited to R&D items, so there are some additional concepts and ideas that may be considered more implementation than R&D.

[8] WBCSD 2009. Transforming the Market. Page 4.

Table 2. Comparison of Recommendations in Transforming the Market and the Federal R&D Agenda

Transforming the Market Recommendation	**Federal R&D Agenda Recommendation**
Strengthen codes and labeling for increased transparency - Policy-makers and governments must extend current building codes to include strict energy-efficiency requirements (adapted to regional climate conditions) and commit to enforcing and tightening these over time. The building industry and governments must also develop energy measurement and labeling mechanisms requiring nonresidential building owners to display energy performance levels. Building energy inspections and audits must be introduced to measure performance, identify improvement opportunities, and establish priorities for implementing efficiency measures. In multi-family residential buildings, tenants must be given access to energy controls for each unit and charged for energy use individually. Such energy inspections in commercial buildings should be incorporated into existing fire and health and safety inspections.	**R&D Focus Area 6b – Develop tools and guides that enable the use of modern, adaptive performance-based building codes** – addresses the needs to 1) update codes and standards, and 2) provide code-based tools and guides. **R&D Focus Area 6c – Research and develop effective incentives for adopting and using innovative technologies and practices addresses the need to develop market-based building valuation metrics and tools** – specifically addresses market-based building valuation metrics and tools. *Comment - The Federal R&D agenda does not mention building labeling by name, but given the interest in this topic, perhaps it should. The WBCSD report also outlines a number of policy decisions (commitment to enforcing and tightening building codes over time, introduction of periodic building energy audits) that are not part of the Federal R&D agenda's scope. However, the concept of "periodic inspection of buildings" could be added to the Federal R&D Agenda.*
Incentivize energy-efficient investments - Governments will need to provide tax incentives and subsidies to enable energy efficiency investments with longer payback periods. Charging structures should be introduced to encourage lower energy consumption and on-site renewable generation. Suitably promoted marketplace behaviors can be expected to accomplish a significant portion of the US$ 300 billion[9] in investments annually leading to a 52% reduction from the IPCC's 2050 baseline. The balance, and investments exceeding the 10-year discounted payback threshold at today's energy prices, will require additional incentives to become reality. Businesses and individuals must work together to develop creative business models to address and overcome the first cost barrier to energy efficiency.	**R&D Focus Area 6c – Research and develop effective incentives for adopting and using innovative technologies and practices addresses the need to provide analysis of financial and regulatory incentives** – specifically addresses incentives and subsidies. **R&D Focus Area 2c – Develop supply-side technologies that, when coupled with energy efficiency, can achieve net-zero energy buildings and communities** – addresses the need to adopt resource-friendly utility rate structures. *Comment –The WBCSD report and the Federal R&D Agenda are in good agreement about the importance of incentives and rate structures but while the WBCSD report comes from the perspective of implementation, the BTRD report is focused on R&D to reduce the cost of that implementation. There is potential to add a specific section on utility barriers to the Federal R&D Agenda's discussion of "Overcoming Barriers to Implementation".*
Encourage integrated design approaches and innovations - Property developers need to	**R&D Focus Area 1b – Enable widespread adoption of high performance goals by**

[9] The $300 billion listed here is the sum of the $150 billion necessary to achieve 40% reduction plus the additional $150 billion necessary to achieve 52% reduction from the 2050 baseline.

Transforming the Market Recommendation	Federal R&D Agenda Recommendation
be encouraged to restructure business and contractual terms to involve designers, contractors and end users early and as part of an integrated team. Governments should introduce incentives for developers to submit applications for energy-efficient buildings. Subsidies and other incentives for domestic energy–efficient improvements should be related to an integrated approach aiming to improve the overall energy performance of the building.	**developing practical tools and processes to address the complex interactions of building components and systems throughout the building life cycle** – is focused entirely on development of tools and processes for integrated design. **R&D Focus Area 6a – Develop high-performance building design tools and guidance for urban planners, architects, engineers, contractors, and owner/operators** – addresses the need for integrated design and collaboration within the entire building life cycle. *Comment – The WBCSD report and the Federal R&D agenda are agreement in recommending integrated design approaches though the WBCSD report is focused on implementation instead of R&D. The Federal R&D Agenda does not address the idea of "incentivizing integrated design" and this could be added to the Federal R&D Agenda's discussion of "Overcoming Barriers to Implementation".*
Develop and use advanced technology to enable energy-saving behaviors - Only a third of the investments required to achieve the IPCC's 77% emissions reduction target have discounted paybacks of 10 years or less, a measure of the opportunity to improve energy-efficiency technologies in building. Government authorities need to provide support and investment for research and development of effective energy-efficient building technologies so that greater rates of advance are technically and readily achievable. New and refurbished buildings should be designed to use information and communication technology that minimizes energy use and is easily updated with technological advances for buildings to operate at an optimal energy level. Technologies exist today but can be improved and extended to countless existing structures accordingly. Utilities can participate by confirming deviations from best practice in regular usage statements.	**Goal 2: Develop net-zero energy building technologies and strategies** – directly addresses the need for research into envelope load reduction, solar heating and lighting, energy storage, natural ventilation, moisture and air infiltration, new construction techniques, efficient building components, increased building intelligence, use of ground energy sources and heat sinks, and better and more cost-effective components and subsystems. Goal 2 also addresses energy supply issues such integrating distributed generation and on-site renewable energy into the grid and energy storage technologies. *Comment – The WBCSD report and the Federal R&D agenda are in good agreement that this research is necessary.*
Develop workforce capacity for energy saving - The building industry must create and prioritize energy-efficiency training broadly for all involved in the sector and create vocational programs specifically for those who build, renovate and maintain buildings. It is also important to develop a "system integrator" profession to support retrofitting in residential properties.	**R&D Focus Area 6a – Develop high-performance building design tools and guidance for urban planners, architects, engineers, contractors, and owner/operators** – addresses the need to provide training and education for the building sector workforce. *Comment – The WBCSD report and the Federal R&D agenda are in good agreement on the importance of training. There is a potential for the Federal R&D Agenda to*

Transforming the Market Recommendation	Federal R&D Agenda Recommendation
	discuss the concept of a "system integrator" for residential retrofits.
Mobilize for an energy aware culture - Businesses, government authorities and others must establish sustained campaigns to promote behavior change and to increase awareness of the impact of energy use in buildings. It is essential to demonstrate their commitment to addressing this urgent challenge by cutting the energy consumption of their own buildings.	**Chapter 7 -Collection, Analysis, and Dissemination of Research Results** – addresses the need for information from Federal research programs to be widely disseminated. *Comment – Dissemination of research results can be part of a campaign to promote behavior change, but there are no research items identified in the Federal R&D Agenda directly focused on awareness campaigns. This type of activity is likely to be carried by deployment programs within the Federal government.*

There are also several concepts expressed in *Transforming the Marketplace* that could be included in the Federal R&D agenda explicitly including:

1) Specific mention of building labeling
2) Periodic building energy inspections
3) Specific mention of utility barriers to implementation
4) Incentivizing integrated design
5) The need for residential retrofit "system integrators"

These 5 items are discussed below in more detail.

<u>Building Labeling</u>

"We recommend a building energy measurement and labeling standard be developed, adapted to regional climate conditions, with an obligation for all non-residential buildings to display the energy performance level.

Information on energy performance must be made public if it is to influence the market. The EU has introduced a mandatory labeling system (through Energy Performance of Buildings Directive – EPBD) that will raise the profile of energy, especially in the residential sector. Voluntary labeling systems (such as BREEAM, CASBEE, Effinergie, LEED, Minergie and PassivHaus) are already raising awareness of building sustainability, though not all focus on energy use. They are increasingly adopted to support regulation and are beginning to influence market prices. A study of 9,000 home sales in Switzerland found that those with the Minergie label achieved a sales price 7% higher than comparable homes without the label.
This kind of labeling provides transparency, stimulates market adoption and provides a basis for regulation. Our modeling demonstrates that labeling schemes with imposed minimum standards can transform energy use, achieving zero net energy outcomes in residential buildings, if effectively enforced."

Comment with regards to Federal R&D Agenda – There is no specific mention of building labeling in the Federal R&D agenda. This may be because there are already numerous building label programs (existing or being developed) in the US. EPA's Energy Star commercial buildings and homes, the recently introduced ASHRAE building labeling program, and a recently announced BOMA labeling program all bear witness to the appeal and perceived value of building labeling in the US. Is there a need for any R&D associated with building labeling? Should building labeling be specifically mentioned in the Overcoming Barriers to Implementation chapter?

Periodic building energy inspections

"We recommend regular inspections be required to check performance of the building envelope and key systems such as heating and cooling equipment.

Actual performance often differs from design, with degradation over time unless installation is correct, maintenance is carried out and people are trained to use equipment properly. For example, windows may cease to be airtight due to building movement. In the US, the Environmental Protection Agency estimates that air leakage typically wastes between 25% and 40% of the energy used for heating and cooling."

"We recommend that building codes enforcement for commercial buildings be incorporated in health and safety, fire and other inspections.

Code enforcement is often inadequate, in developed as well as developing countries where much building takes place beyond the scope of formal approvals and standards in commercial buildings. This is often due to a lack of effective inspection resources, but also because building standards inspectors lack the level of authority of other compliance teams, such as health and safety inspectors. Enforcement of codes could be improved by incorporating building standards in health and safety and other regular audits such as fire inspections in commercial buildings. Some sectors have inspection processes that could include building energy, for example food safety inspections for restaurants."

Comment with regards to Federal R&D Agenda – There is no specific mention of the need for periodic inspections of energy use or energy using features of buildings in the Federal R&D Agenda. The actual requirement for inspections is not so much an R&D item as it is a political issue, so mention of this in an R&D agenda may not be necessary. However, the working group should consider if there is a need for additional tools to help with these types of inspections as an R&D activity.

Utility barriers to implementation

"We recommend charging structures to encourage lower energy consumption and on-site renewable generation.

There are two other ways to shift the financial equation in favor of energy-efficient investment – reduce the first cost or increase the savings in the early years. One widely recognized way of increasing potential savings is to increase the cost of energy, which would happen if post-Kyoto agreements result in higher carbon prices. These are useful mechanisms across the broader economy, but our modeling shows that they are likely to have a limited impact on energy investment decisions if set at a level that is acceptable politically and economically. Even a relatively high carbon price does not add enough to the energy cost to make energy savings sufficiently attractive (although rising prices may influence behavior by highlighting the need for energy saving).

Potential savings can be increased through commercial means. In some countries, utility charging practices may encourage waste because of discounts for higher use – the unit rate typically declines above specified consumption levels. Reversing this practice would increase the cost of energy at higher consumption levels. This is already the case in Japan, where the first 120 kWh are charged at Yen 17.87/kWh (18 cents), increasing to Yen 22.86 (23 cents) up to 300 kWh and Yen 24.13 (24 cents) above that level.

A high feed-in tariff for renewable energy supplied to the grid may encourage investment in on-site renewable generation as is already the case in countries like Germany and France."

Comment with regards to Federal R&D Agenda – There is specific mention of utility rate structures and the need for resource-friendly rate structures in the Federal R&D Agenda. However, this discussion occurs under Goal 2 and is not included in Barriers to Implementation (chapter 6). There could be a separate section in the Barriers to Implementation chapter that emphasizes the utility-specific barriers and ways to overcome them.

Incentivizing integrated design

"We recommend that government authorities introduce process incentives for developers to submit applications for energy-efficient buildings based on a holistic approach.

Whole-system design approaches including both passive and active measures can reduce energy use by as much as 70%. Yet the segmented structure of the building industry hampers attempts to bring together the different players in an integrated project team. The role of agents can be a brake on innovation, as they are typically preoccupied with financial criteria, which can reinforce a conservative approach to building design.

Measures are needed to incentivize property developers in particular. The bidding process hampers integrated approaches. The key issue for a developer is the significant risk of not winning approval for a project; some 90% of commercial projects never get off the drawing board. This encourages developers to minimize costs during the early phase of a project. Bringing together the different specialists in an integrated team would add costs at this stage, increasing losses if the project is not approved. But early integration significantly reduces rework and construction costs. Reducing the risk of failure would be a significant incentive for developers. This could be achieved by giving fast-track and preferred status to development submissions that demonstrate they use an integrated team to create a holistic design to reduce energy use. Relaxing some regulations would also provide an incentive – for example, allowing higher occupancy densities than usual for high-performing buildings.

The corollary of this is that as building energy codes and standards are tightened, developers are only likely to meet the requirements at reasonable cost by adopting a whole system approach."

Comment with regards to Federal R&D Agenda – Goal 1, and especially R&D Focus Area 1b is all about integrated design. However the focus of the Federal R&D Agenda is R&D and not so much incentives. Chapter 6 (Overcoming Barriers to Implementation) mentions analysis of financial and regulatory incentives, but there is no specific mention of the need to incentivize integrated design. There may not be an actual R&D component to a decision to incentivize integrated design and therefore it may not be suitable for inclusion in the Federal R&D Agenda.

Residential Retrofit "System Integrators"

"We recommend developing a "system integrator" profession to support retrofitting in residential properties.

Shortages of skilled workers could limit the capacity to carry out wide-scale retrofitting, especially integrating the different aspects of energy-efficient renovation. Retrofitting is specified and carried out by specialists, usually skilled in only one aspect of the work. As we want to see integrated retrofits, it will be necessary to develop workers with the skills necessary to manage and integrate the process. They would be able to assess energy-efficiency requirements and develop a whole-house plan, select appropriate contractors and manage the retrofit process."

Comment with regards to Federal R&D Agenda – There are several mentions of the need for training for building operational staff and other individuals involved in the building construction and operation industry. However, there is no specific mention of training for or development of a system integrator specific to residential properties. This suggestion is very much in line with

the recommendations from the National Research Council of the National Academies 2002 report "Promoting Innovation: 2002 Assessment of the Partnership for Advancing Technology in Housing" that is quoted in the Federal R&D Agenda. The concept of a residential "system integrator" could have been discussed in the Federal R&D Agenda in conjunction with this, however it is not clear that there is a significant research component associated with "system integrator".

Appendix A: Overview of World Business Council for Sustainable Development

Adapted from the WBCSD website

The World Business Council for Sustainable Development (WBCSD) is a CEO-led, global association of some 200 companies dealing exclusively with business and sustainable development. The Council provides a platform for companies to explore sustainable development, share knowledge, experiences and best practices, and to advocate business positions on these issues in a variety of forums, working with governments, non-governmental and intergovernmental organizations. Members are drawn from more than 35 countries and 20 major industrial sectors. The Council also benefits from a global network of about 57 national and regional business councils and regional partners.

The Council's objectives are to:

- Be a leading business advocate on sustainable development;
- Participate in policy development to create the right framework conditions for business to make an effective contribution to sustainable human progress;
- Develop and promote the business case for sustainable development;
- Demonstrate the business contribution to sustainable development solutions and share leading edge practices among members;
- Contribute to a sustainable future for developing nations and nations in transition.

In order to achieve this, the Council focuses on four key areas: Energy and Climate, Development, The Business Role, and Ecosystems. In addition, we have projects and initiatives covering the following topics:

Council projects:	Energy Efficiency in Buildings
Sector projects:	Water, Cement, Electricity Utilities, Forest Products, Mining & Minerals, Mobility, Tire Industry
Initiatives:	Eco-patent commons

Appendix B: Overview of WBCSD Energy Efficiency in Buildings Working Group (from WBCSD Website)

Adapted from the WBCSD website

Buildings today account for 40 percent of energy consumption in developed countries according to the OECD. The effort announced today for transforming the way buildings are conceived, constructed, operated and dismantled has ambitious targets: By 2050 new buildings will consume zero net energy from external power supplies and produce zero net carbon dioxide emissions while being economically viable to construct and operate.

Constructing buildings that use no net energy from power grids will require a combination of onsite power generation and ultra-efficient building materials and equipment.

The project will comprise three phases, each producing reports that together will form a roadmap to transform the building industry. The first report will document existing green building successes and setbacks, the second will identify the full range of present and future opportunities, and the third will present a unified industry strategy for realizing those opportunities by 2050, specifically in China, India, Brazil, the U.S. and the E.U.

Each report will take one year to complete and involve hearings and conferences with building contractors and suppliers, sustainability experts, government representatives, regulators, utility officials and others.

"Green" buildings already are erected in various parts of the world but current cost structure prevents widespread adoption by general contractors. The project will build on these examples, aligning costs and benefits in the building equation and by working in close collaboration with architects, builders, suppliers and building owners to promote a more sustainable approach to construction. Existing standards for energy efficiency in buildings will be the starting point for the industry-led alliance.

Why do this project?

- Buildings today represent 40% of world's energy demand, 33% in commercial buildings and 67% in residential.
- Worldwide energy consumption for buildings is expected to grow 45% from 2002 to 2025.
- Scenarios forecast an acute increase in global carbon emissions; 92% increase from 2002 to 2050, if current trends are not altered.
- Leading global businesses are putting their resources and efforts into this issue, to secure sustainable growth for our planet and the future. The core group consists of 14 companies; Actelios, ArcelorMittal, Bosch, CEMEX, DuPont, EDF, GDFSuez, Kansai Electric Power Company, Philips, Skanska, Sonae Sierra and TEPCO – with Lafarge and United Technologies Corporation taking a leading role. More than 40 other global companies will also be participating in the effort.
- A global assurance group of experts will be formed to advise and validate the project.

The work will maintain a holistic and transparent approach, and collaborate closely with stakeholders from the different work streams as well as governments, academia and NGOs.

- New technologies and practices have been developed with regard to improved energy efficiency in buildings, but few are being implemented on scale. This project will attempt to draw these innovations together, addressing all aspects of a building's lifecycle, in order to raise awareness, advocate and promote action.

Appendix C: Overview of the Members of the WBCSD Energy Efficiency in Buildings Working Group

WBCSD Energy In Buildings Working Group Members are listed below, along with quotes from company home pages and some indication of industry or name brands associated with company.

Lafarge (Co-chair)	"world leader in building materials"
United Technologies Corp. (Co-chair)	"high technology for building and aerospace industries" (Carrier, Otis)
Actelios	"Power from Renewable Sources"
ArcelorMittal	"world's number one steel company", "steel infinitely recyclable"
Bosch	"Bosch is focusing on solar power"
CEMEX	"We are one of the top building materials companies in the world"
DuPont	"The miracle of science", "sustainable solutions essential to a better, safer, healthier life for people everywhere"
EDF	"EDF is investing in the global resurgence of nuclear power, the development of renewable energies and energy efficiency, while strengthening its European base."
GDF SUEZ	"Producing energy that is more respectful of mankind and the environment"
Kansai Electric Power Company	"nuclear power, thermal and hydroelectric power, transmission and distribution"
Philips	"simplicity in healthcare, lighting, and consumer products"
Skanska	"Skanska is one of the world's leading construction groups with expertise in construction, development of commercial and residential projects and public-private partnerships."
Sonae Sierra	"Sonae Sierra is the international shopping centre specialist that is passionate about bringing innovation and excitement to the shopping industry."
TEPCO	"Contribute to the realization of affluent living and a pleasant environment by offering optimal energy services" (nuclear power)

Appendix D: Publications of the WBCSD Energy Efficiency in Buildings Working Group

Adapted from the WBCSD website

Transforming the Market: Energy Efficiency in Buildings

New modeling by the WBCSD shows how energy use in buildings can be cut by 60 percent by 2050 – essential to meeting global climate change targets – but this will require immediate action to transform the building sector. This is the central message of the report from the WBCSD's four-year, $15 million Energy Efficiency in Buildings (EEB) research project, the most rigorous study ever conducted on the subject. April 2009

Energy Efficiency in Buildings Executive Brief #2 - Our vision: A world where buildings consume zero net energy

Buildings are responsible for about 40% of energy use in most countries. The EEB project will determine which combination of recommendations will most effectively result in substantial energy and emission reductions, putting us on a committed path towards zero net energy buildings. November 2008

Energy Efficiency in Buildings Facts & Trends - Full report

14 companies headquartered in 9 countries have studied and synthesized an exceptional data set reflecting more than 100 billion square meters of building floor space and two-thirds of world energy demand. The result is a significantly more detailed view of the current state of energy demand in the building sector than has previously been compiled. September 2008

Energy Efficiency in Buildings - Summary report

This study highlights opportunities to promote green building know-how and technologies as the WBCSD pushes for zero net energy construction worldwide through its Energy Efficiency in Buildings (EEB) project. Zero net energy buildings will reduce demand by design, be highly efficient and generate at least as much energy as they consume. August 2007

Energy Efficiency in Buildings Executive Brief #1 - Our vision: A world where buildings consume zero net energy

Buildings use about one-third of the world's energy. Leading companies in the building, equipment and energy industries launched Energy Efficiency in Buildings (EEB) with the WBCSD in March 2006. The project brings together companies worldwide, which are determined to remove barriers to energy-efficient concepts in new and existing buildings. September 2006

Appendix E: 0utline of Transforming the Market (by Paul Domich)

- Four year study that began prior to the energy price run-up and completed after the price fall
- Focused on six markets:
  - Brazil
  - China (Case Study: multi-family homes)
  - Europe (Case Studies: single family homes - France, Retail - UK)
  - India
  - Japan (Case Study: offices)
  - United States
- Three scenarios:
  - **Complacency** - A continuation of current trends in urbanization, economic growth and energy use, with no sustained attempt to address energy efficiency.
  - **Incremental** - Awareness grows, action is piecemeal rather than coordinated. Limited progress through voluntary or mandatory labeling and other regulations.
  - **Transformational** (focus of this report) - Represents a mix of measures tailored to specific subsectors and geographies and includes:
    - Strict building energy codes, regulatory requirements
    - labeling and reporting mechanisms
    - appropriate energy prices and carbon costs
    - investment subsidies and incentives
    - increased and trained workforce capacity
    - evolving energy-efficient designs and technologies that use passive and active approaches

Conclusion 1: At energy prices proportionate to oil at US$ 60 per barrel, building energy efficiency investments in the six markets studied, totaling US $150 billion annually, will reduce related energy use and carbon footprints by 40% with five year discounted paybacks.

Conclusion 2: A further investment of US$ 150 billion with paybacks between five and ten years will add 12 percentage points (52%). Additional investments to achieve the 77% target will not be justifiable on economic return grounds at today's energy prices and will require the additional steps outlined in this report

Conclusion 3: increasing the price of energy or carbon will only slightly increase the implementation of energy-efficient options - Reductions would only marginally increase from 52% at today's energy prices to 55% with an incremental carbon cost of US $40/ton.

Premise of the Report: The necessary progress will not be achieved purely through the market. Market forces will need to be supplemented by effective regulatory environments and fundamental behavior change.

Regulatory/Policy Key Questions

- How can we improve transparency of energy consumption in buildings, spreading knowledge on how and where energy is used?
- How can we create incentives that reward progress and penalize poor performance?
- How can we finance the cost of developing and commercializing new technology?
- How can we overcome the first-cost barrier and short-term investment horizons that impede energy efficient investment?
- How can we spread best practice and innovation in financing measures and mechanisms, new technologies and behaviors?

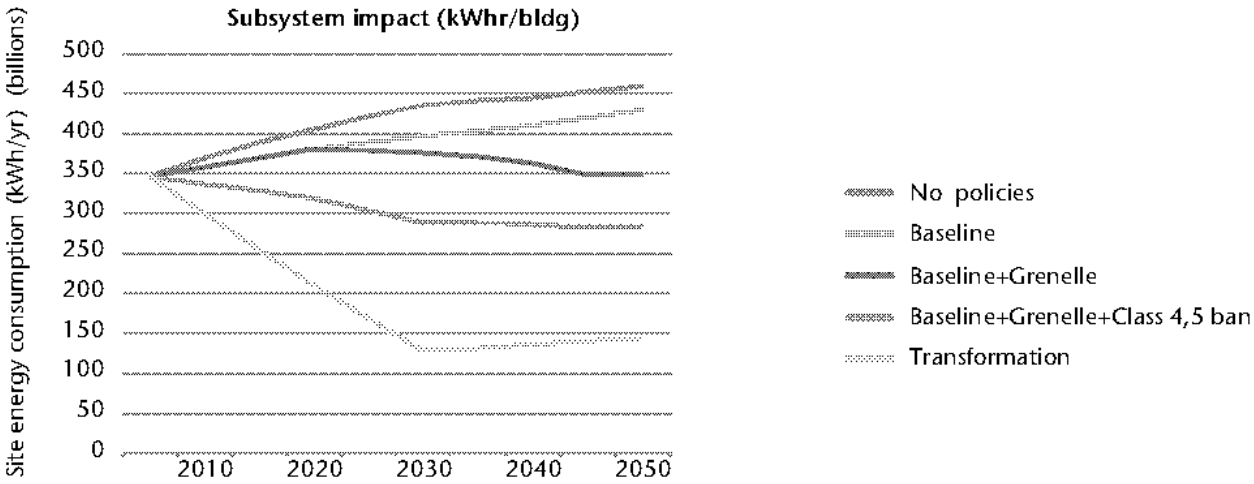
- How can we develop a low-energy mindset so that energy efficiency is part of the modern lifestyle and a source of competitive advantage?
- How can we achieve action: behavior change by everyone in the building sector as well as building users?

Barriers:

- Based on specific building subsectors and realistic decision criteria, measures that have a substantial impact are unlikely to meet normal financial investment requirements and are therefore unlikely to be implemented.
- A lack of transparency about energy use and cost, resulting in a limited focus on energy costs by all those in the building value chain, with viable investment opportunities overlooked and installed technology not operating at optimal levels
- Public policies that fail to encourage the most energy-efficient approaches and practices, or actively discourage them
- Delays and poor enforcement of policies and building codes, which concerns all countries
- Complexity and fragmentation in the building value chain, which inhibits a holistic approach to building design and use (described in our first report6)
- *A lack of adequate offers today (affordable and quality energy-efficient solutions for new constructions and retrofitted works, adapted to local contexts)*
- Split incentives between building owners and users, which mean that the returns on energy efficiency investments do not go to those making the investment
- Insufficient awareness and understanding of energy efficiency among building professionals – identified in EEB research published in our first report – which limits their involvement in sustainable building activity and results in poor installation of energy-related equipment

Example Recommendations: Japan Office Buildings:

- Audit energy performance of office buildings; introduce labeling systems to provide transparency; and enforce increasingly strict building energy codes
- Introduce heavy subsidies for achieving high performance in existing and new buildings
- Regulations to phase-out low performing buildings, equipment and lighting
- Require office-level controls and charging according to use in multi-occupied buildings
- Introduce process incentives for developers to adopt integrated design approaches achieving high energy efficiency
- Promote energy service companies as effective energy managers for large office owners, especially public buildings
- *Promote research and development of highly efficient equipment and lighting*
- *Promote onsite renewable generation for all low-rise, new office developments*
- *Create a technical offer for onsite renewable generation, using R&D to drive down first cost and identifying retrofitting solutions*
- Include energy efficiency in routine health, safety and fire inspections and re-commission as necessary to ensure achievement of design standards
- Launch an education and awareness campaign to raise awareness of energy use and cost, elevate the status of facilities management engineers and encourage wider comfort tolerances

France Case Study: Single Family Residence (examples of impacts dieregulatory and policy changes)

- For Transformation, additional aggressive policies are added to the Base case, including policy measures as defined by “Grenelle de l’ Environnement” (for example, a requirement in 2020 for all new construction to be “net zero energy”), as well as a US$ 30 per tonne carbon tax. In addition, a combination of incentives and bans are imposed based on a five-level building energy efficiency classification system (comparable to the European Energy Performance of Buildings Directive A-G labeling scheme). Class 1 and 2 buildings receive an incentive of 50% and 25% of capital costs respectively, and Class 4 and 5 homes are banned. These very aggressive policies drastically reduce energy (-53%) and CO2 emissions (-71%) by 2050 *(see figure 16)*. A steep reduction in energy consumption until 2020 is achieved, followed by a slight increase due to market growth (new homes are built with the most efficient energy equipment; therefore there is no more gain in energy efficiency).