Futuropolis 2058:

Creating Sustainable Urban Environments through Innovation

Wednesday, 22 Oct 2008

Green Buildings

Forecasting Their Impact On Energy Patterns

Huston Eubank
V.P. for Knowledge and Community
iLiv Technologies Inc.
www.iLiv.com

Former Executive Director
WORLD GREEN BUILDING COUNCIL

Introduction

Back around 1958 Walt Kelly famously wrote, "We are surrounded by insurmountable opportunities." That old quote from Pogo, the American comic strip, fairly sums up the situation in today's transition to clean energy and green building – or even to sustainability as some people are calling it. There has been an almost logarithmic increase in interest and action just in the past three years alone. Clean energy is even being called the next big market bubble.[1]

We have a very long way to go, however, and no matter what we do there are some very tough times ahead for humanity and the planet's other inhabitants. But there is hope that we may be close to achieving critical mass and getting the reaction started that is needed to change the way humans interact with the natural environment so that we can indeed live sustainably.

The implications of the shift are shaking business-as-usual to its core. The current global financial trauma is having some impact on this development. International tensions are also significant factors. However, most sources believe that commitment to solving environmental problems has become deeply entrenched in all elements of society and will survive these challenges. Society has shifted the basis on which we do business in favor of a healthier environment. The current crisis could even accelerate the transformation because it has substantially weakened the pull of the past.

Two weeks ago, Björn Stigson, president of the World Business Council for Sustainable Development, wrote in the Financial Times,

> *The current financial crisis should be seen as the result of unsustainable business models…Industries that have put sustainability issues at the heart of their strategy offer some valuable lessons for the financial sector…There is no future for a successful business if the societies that surround it are not working…The companies that continue to demonstrate thoughtful responses to society's needs, and are planning for a changing future, will be among those that will still be operating successfully many years from now.*

Given the proper tools, all the people in this photograph can become part of the solution. That's critical, because, given the size of the problems we've created, it will require all of us working together to solve them. Sustainability is not something that someone else is going to do for us, or something that we can pay others to do for us. Speaking personally, the changes we need to make to think and act sustainably represent an essential next step in the evolution of intelligent life on the planet.

The Work of Cities Around the World

I've been asked to summarize activities around the world from my perspective as a former director of the WorldGBC. So naturally I'll start with them. We're going to cover a tremendous amount of ground in the next few minutes. Unfortunately I'll only be able to hit the high points on a high level overview, and a very quick one at that. I've tried hard to include only what I think are the most important ideas for you to consider.

The WorldGBC now has 13 full members (Australia, Brazil, Canada, United Arab Emirates, Germany, India, Japan, Mexico, New Zealand, South Africa, Taiwan, UK, USA) and 7 emerging members (Argentina, Viet Nam, Romania, Poland, Colombia, Netherlands, Italy). Many other countries (notably China, Singapore, Indonesia, Spain, and Chile) are organizing councils with the intent to join.[2]

[1] "The next bubble: Priming the markets for tomorrow's big crash," by Eric Janszen, Harpers, February 2008. http://harpers.org/archive/2008/02/0081908

[2] The Scandinavian countries are already quite advanced and may not feel the need to create councils.

Collectively the current member countries represent approximately 50% of all the construction activity on earth. If these individual councils can achieve anything like the success of the USGBC in raising awareness and providing effective tools to change the industry, then we have a powerful force here indeed. And we have good reason to expect that they can. It's a pretty good start.

Green building rating systems are primarily market transformation tools. They stimulate market demand for buildings with improved environmental performance, and provide "branding" for high performance buildings. Through companion mechanisms such as education programs and accrediting professionals, they transform the skills and knowledge of the industry as a whole. By structuring environmental criteria in an organized fashion, green building rating systems create a common language and offer a structure and focus for project teams. They provide methods for deliberation and decision-making that actively involve the relevant interests of all stakeholders in a project.[3]

There are as many as 40 green building rating systems around the world. They predate the councils, which were largely created to support their uptake. The granddaddy of rating systems is the British BREEAM that claims to have about 100,000 individual buildings certified in the UK. It is used by two WGBC members, and has recently begun ramping up to compete globally. The best known and arguably the most successful is the USGBC's LEED system, which is used by at least 7 of the WGBC's members. The USGBC is massively increasing its capacity to deliver LEED certifications, and is aggressively promoting LEED globally. The Australian system Green Star is a blend of these two systems, and they are staking out territory in the southern hemisphere, with New Zealand and South Africa now aboard. The remainder of WGBC members either have or are creating their own system, or are still deciding which one to choose. The Emirates' decision may be made for them by the city of Dubai, which has mandated the use of an international system for every new building in Dubai, but hasn't yet specified which one (or created their own).

Early WGBC members supported these multiple initiatives on the theory that they could not mandate a common system even if they could agree on one, and there could be a lot to learn from encouraging further explorations. Most likely, the higher order principles of sustainability are the same everywhere, but their application varies in ways that are appropriate to each country or region—culturally, climatically and economically—and to their needs, values and priorities. In addition, local consensus development is essential to create ownership, buy-in, and voluntary participation.

This is still—and perhaps increasingly—the case, much to the frustration of multi-national corporations that would like to be able to report on and compare their global operations using one common set of metrics. (They would also like not to have to join and support multiple councils).

However, others are rising to meet this need, including a major effort well underway by the International Standards Organization, an effort by the Global Reporting Initiative, and a tentative new group, the SB Alliance, co-founded by the French and UK building research organizations. Their goal is to develop a universal core building assessment system. This new organization claims to have 20 member countries.

LEED is currently being translated into language that can easily be incorporated into building codes. Given the public's current level of interest in environmental issues, and the property industry's interest in proven tools for lowering climate change emissions, it is likely that these requirements (or ones like them) will be assimilated into building codes relatively quickly. This has real potential to have a much larger impact than the voluntary programs to date.

There are many more initiatives, such as UNEP's Sustainable Building and Construction Initiative (SBCI), which is focused in part on a serious deficiency in the Kyoto protocol that effectively precludes the building sector from participating in the Clean Development Mechanism (CDM).

It is important that these emissions trading schemes include the building sector because of the size of its contribution to global greenhouse gas emissions; its enormous potential for quick, deep and cost-effective abatement; and the raft of co-benefits that abatement will deliver.

One of several private sector efforts that support the UNEP initiative is the Integrated Emissions & Efficiency Trading Scheme (EETS) put forward by Lend Lease Corporation and the Australian engineering firm Lincolne Scott.[4] It addresses emissions reduc-

[3] Loosely adopted from a paper entitled "Building Environmental Assessment Methods and Market Transformation in North America" by Ray Cole presented at the International Workshop on Strategic Market Transformation conference in Tokyo, 12 Dec 2006.

[4] The full submission is on the Garnaut Climate Change Review website. http://www.garnautreview.org.au/CA25734E0016A131/WebObj/ETSSubmission-LendLease-LincolneScott-

tions at the design, construction/ refurbishment and operation phases of both new and existing buildings. It proposes a 'carrot and stick' approach that would unlock innovation, stimulate broad action on existing buildings, and enable owners to make a competitive return on their investments in emissions reduction.

Other initiatives include the Clinton Climate Initiative which is working with the C-40 Cities Climate Leadership Group on a US$5B+ program to upgrade existing buildings in 40 major cities around the world; the widely endorsed American Institute of Architects 2030 Challenge which aims for carbon-free buildings by 2030; and a major initiative by the World Business Council on Sustainable Development (WBCSD) that is making some substantial progress on developing and mainstreaming technology to support net-zero-energy buildings.

In the face of gridlocked national governments (such as the US and others), a lot of the real action is happening at the city level, or occasionally the state/province level where the growing or looming impacts are more closely felt. It seems as if every city is suddenly embracing green building programs and declaring its intention to be the greenest city on the planet. Which one is actually the greenest depends on who you talk to and when you talk to them.

In addition, major new developments, several on the scale of a half-million people, are appearing and announcing significant sustainable intentions. These include Dongtan and Taijin in China (Singapore is a partner in Taijin), Masdar and Koast in the Middle East, Song Do City in Korea, and Clonburris in Ireland.

Major government initiatives include the European Union's programs such as the "Energy Directive", Germany's ambitious—and reportedly highly successful—program to achieve 27% renewable energy by 2020, and a variety of internal and external programs targeting energy efficiency and renewable energy in China and India.

Simply reciting the names of all the programs currently operating around the world would take much longer than my allotted time here today.

AdvancedEnvironmental(jointsubmission)/$File/ETS%20Submission%20-%20Lend%20Lease%20-%20Lincolne%20Scott%20-%20Advanced%20Environmental%20(joint%20submission).pdf The Garnaut Review, headed by Professor Ross Garnaut, was appointed by the Australian Federal Government to examine the impacts, challenges and opportunities of climate change for Australia, including the design of a national Emissions Trading Scheme.

Potential for Energy Efficiency Improvements in Buildings

Now let's turn to the potential for energy efficiency improvements in buildings. In brief, the potential is enormous and exciting. But it may not lie in the areas where most people are looking.

Buildings are the single most important contributor to the greenhouse gas emissions that cause climate change.[5] The building sector is responsible for approximately 40% of global climate change emissions, depending upon where you draw the boundaries between uses. Spin off effects from buildings account for approximately another 30%. These effects include transportation energy required to move goods and people between buildings, and the manufacture of goods used in them. So buildings and the cities they constitute are a particularly rich leverage point for driving change and addressing climate change.

At the same time, the things that we do to make our buildings and cities more energy efficient are the cheapest things we can do to reduce GHG emissions.[6] In fact, they actually *make* money!

These two facts make the building sector a particularly attractive and effective leverage point for addressing climate change. They make it especially important that we succeed in including coordinated building efficiency efforts in the Kyoto protocol.

To date, the most effort and the most progress has been made on greening new construction. However there is a broad awakening that improving the performance of the massive stock of existing buildings globally has a much higher potential, and is essential for GHG reduction.

The motto of the industrial revolution, and especially of the twentieth century, seems to have been, "If brute force isn't working you aren't using enough of it." We can be a lot smarter than this—and we have to be.

The famous equation for environmental impact popularized by Paul and Anne Ehrlich is I = P x A x T, where I = environmental impact, P = population, A = affluence, T = technology. If this is true there is no hope for the planet as the population burgeons out of control, and all of those people rise to match North America's level of affluence. Technology is a multiplier in this equation, and when that technology is the kind we've had in the recent past, that's a very bad thing.

The green architect Bill McDonough and Ray Anderson, CEO of Interface Carpets, have proposed a modification to the equation that makes sustainability possible, even in the face of the overshoot of planetary carrying capacity that we must deal with in this century. I = P x A / T.[7] Moving technology to the denominator is a massive change that makes technology part of the solution as opposed to part of the problem. This describes the shift we are beginning to see from industrial revolution technology to sustainable technology.

According to McDonough and Anderson, the characteristics of sustainable technology include:

- renewable, as opposed to extractive and finite
- emulates nature: no waste
- cyclical: cradle to cradle versus cradle to grave
- focused on resource productivity rather than labor productivity
- benign and even restorative in its effects on the biosphere

This is basically a natural model. In fact, learning from and learning to work like natural models is a rich, inspirational and compelling strategy for improving the performance of all man-made systems. This field, which is called "Biomimicry" or "biomimetics" is the focus of substantial research and development efforts

In her book *Biomimicry* Janine Benyus lists the following principles of biomimicry:

- Does it run on sunlight?
- Does it use only the energy it needs?
- Does it fit form to function?
- Does it recycle everything?
- Does it curb excess from within?
- Does it reward cooperation?
- Does it tap the power of limits?

We can easily make our buildings 30 to 50 percent more efficient, and that's a good start. But we are learning how to make our buildings work more like natural systems. Buildings are becoming generators

[5] Pew Center on Global Climate Change "Innovative Policy Solutions to Global Climate Change," In Brief, November 2006

[6] Source: Vattenfall/McKinsey. See "Buildings--the Biggest Bang for the Buck in Global CO2 Abatement," by Jeremy Faludi, WorldChanging, 6 August 2008, http://www.worldchanging.com/archives/008316.html

[7] *Mid-Course Correction*, by Ray Anderson, Chelsea Green Publishing, 1998, pg. 10

of energy and clean water. Zero-impact or even net-restorative buildings are possible.

Unfortunately, in the past, government, utility, and corporate programs have typically targeted efficiencies on the order of 10%. Performance at this level will never solve our problems. There are many ways by which we can achieve efficiencies well in excess of 50% at minimal or no cost. However, even 50% is not enough. Today several programs are targeting—and achieving—net-zero energy performance or even better—net-positive projects. Given the problems society is facing today we can no longer be satisfied with lesser results.

Achieving performance at these levels is a true strategic step forward in reducing our impacts on the climate. In fact, performance at any lower level will not solve the problem.

Interest in the green building community seems to be moving rapidly to this new understanding. People get the concept very quickly, and intuitively understand that just doing a little better is not going to solve global problems. We need to reinvent the way we house ourselves and our activities.

Just as in a twelve-step program, the first step in achieving performance on this order is to understand exactly how inefficient most systems are today.

- 91 percent of total energy is wasted every single day rather than becoming useful work
- Only 15 percent of the energy we burn in our cars moves the car itself. Only one percent actually moves the driver.
- Taking this car analogy further, the average economy car uses 70HP to drive. The average human expends 1/10th of a horsepower riding a bike. Therefore owning a low-end economy car is like having 700 rickshaw drivers at your beck and call.
- It's possible to make a full-sized automobile that will run on the amount of energy that today is required to run just the air conditioning system.
- Rail and other kinds of transit are between six and eight times more efficient than single-occupant autos.

Using energy more efficiently is where the biggest, easiest and cheapest gains are to be found. The basis of making any system efficient is to first reduce the amount of energy required to make the system work, then find the most efficient means to supply the remaining energy required.

George David, the CEO of United Technologies and a strong supporter of the WBCSD Net-Zero energy program mentioned earlier, says that efficient use of energy boils down to three points: use less energy, make more energy locally, share surplus energy.[8] This is a very simple way to organize and understand some very large issues. We already know how to do each of these very well, and all the technology we need is on the shelf. Here are a few specific ideas:

First, use less energy (efficiency).

- Establishing optimal (aggressive) performance levels is a very high potential area. The potential to reduce demands in existing and new buildings is far greater than most people—even supposed experts—understand. Small goals yield small results; big savings are cheaper than small ones.

- Proper orientation of buildings optimizes their use of the natural energy available from the sun and wind. Simply paying attention to this factor can reduce a building's energy consumption by 30%.

- Insulation and air sealing are the cheapest, easiest, most effective, and most significant technological things we can do to reduce energy usage in buildings. This strategy is especially applicable in the residential sector where the ratio of exterior surfaces is greatest. There is plenty of room to develop new technologies in this arena, such as highly-efficient soy-based foams that have recently come to market.

- High-performance windows (glazing) are another extremely high potential area, and an excellent place for further research. A single pane of ordinary glass has a U-value of 0.18, meaning that it allows almost 100% of the heat or cold that touches it to pass through.

- Roofs that reject heat (green or white) help reduce the effect of heat buildup in urban areas due to surfaces that absorb more heat than naturally vegetated systems. Urban areas have been shown to have temperatures on the order of ten degrees higher than the surrounding countryside, and to have their own weather systems based on this differential.

- Future proofing: Designing flexibility into our buildings that will allow them to adapt to changes in

[8] "My message is the optimistic but realistic one." Remarks by George David, Chairman & Chief Executive Officer of United Technologies Corporation at USGBC Greenbuild conference in Chicago, United States, 7 November 2007. At http://www.wbcsd.org

use over time, rather than become obsolete and unusable.

- "Sewer mining" is the practice of pulling water from the sewer main, cleaning it on-site in your building, and using it for non-potable uses such as flushing, sprinklers, irrigation. This is becoming quite common in drought-plagued Australia.

One of the best examples of this last point is the work of Eng Lock Lee, an engineer who works here in Singapore. Lee is world renowned for his incredibly efficient designs—both performance-wise and cost-wise—and teaches the world how to achieve those same results. His designs are literally the most efficient central plants in the world. I've studied his work extensively and am currently working on ways to leverage his thinking into large property portfolios of existing and new buildings globally.

Lee has completed numerous projects throughout Asia and elsewhere that typically reduce energy consumption on the order of 50%, even though the only systems he usually touches are the mechanical systems, and not the components of a building that determine the amount of capacity required in those systems—such as insulation and lighting. And he has provided long-term guarantees of those results.[9] This has to be put into perspective by comparison to his competitors—energy service companies whose results are typically on the order of 10% reductions.

One of Lee's most important but relatively simple strategies is to make good use of highly accurate information available through continuous online monitoring. Believe it or not, this principle is actually a contentious point among some building system engineers.[10] But it is well known that we cannot manage what we do not measure, and an inaccurate measurement can be worse than none at all. Without continuous online monitoring with very high accuracy instrumentation it is not possible to achieve and maintain the world-record-setting performance Lee does. The proof is in the pudding. As far as we know his team are the only folks in the world doing this. And many performance contracts are pushing for reduced monitoring, substituting instead modeling and hand-waving.

[9] "How the Grand Hyatt Singapore Saves US$700,000 a Year" by Robert Allender, MD of Energy Resources Management, and Hotel Asia Pacific columnist, October 2003, at http://www.hotel-energy.com/resources.html

[10] "Making Energy Efficiency Accountable," by Thomas Hartman, P.E., Automated Buildings.com, June 2007. http://www.automatedbuildings.com/news/jun07/articles/hartman/070528120909hrtmn.htm

The second point on the UTC list is to make more energy locally. Some examples include:

- On-site generation or Combined Heat and Power (CHP). The city of San Francisco is highly energy constrained. Due to its location on a fully developed peninsula, it is almost impossible to site a new power plant, or even just to run new powerlines into the city. As a result, more than 100 large-scale office buildings in SF have installed their own generating capability, using very low-emission equipment (and also renewable energy). This provides multiple benefits, including reliability and power quality. Most importantly, however, the ability to serve multiple purposes—electricity supply, heating and cooling—with the same amount of fuel that would otherwise be used to serve only one of these uses, vastly increases the efficiency of that fuel use.

- Geothermal and ground-storage: Increasingly we are tapping into heat reserves underground. I think of this as a planetary-scale solar collector, but there are also residual heat resources deep within the earth. Typically we simply use that thermal differential to meet our immediate need. But more sophisticated strategies are emerging. The Reichstag building in Berlin boasts a 94% reduction in energy usage, largely due to an innovative geothermal system that stores excess heat underground in the summer for use in the winter, and the reverse for cooling.

The third point is to share surplus energy. Some examples include:

- District heating and cooling: Office buildings use energy at different times than residential buildings. Often one system can supply both uses more efficiently than separate ones. This can be done on a one-to-one basis, but it's much more effective when you can serve a large area containing a diversity of uses. District heating and cooling systems accomplish this goal, and further they can use waste heat from other processes such as electricity generation. Combining all these elements can create efficiencies at very high levels – on the order of 80% or even higher. This practice is fairly common in Europe.

- Enclosing large areas enables buildings to consume dramatically less energy.

Once we've done everything possible to reduce the amount of energy required, then and only then do we look for the most efficient sources for the remainder. There are thousands of ideas being re-

searched and developed today. The successful ones will be the basis of tremendous new businesses, creating huge new investment and job opportunities.

This list of technologies being pursued is from a European Union program called "21 'RenewableS' renewable energy technologies for the 21st century":[11]

Electricity production

1. Hydro power
2. Biomass (solid, gas, liquid)
3. Wind
4. Geothermal (High temperature)
5. Solar photovoltaic (PVs)
6. Solar thermal electricity
7. Energy from waves
8. Energy from sea currents (tidal energy)
9. Energy from osmoses (difference of pressure between river and salt water)
10. Upwind power stations (power plants which play on the fact that warm air is lighter than cold air and creates a flow of air from the soil to the sky)

Heating and cooling

11. Passive solar architecture
12. Surplus low temperature energy from co-or tri-generation plants (based on biomass or geothermal)
13. Solar collectors for heating, cooling and drying (industrial use)
14. Geothermal (low temperature)
15. Wood pellets / wood chips
16. Dried and pressed biomass from energy crops

Fuel production

17. Plant oil
18. Biodiesel RME
19. Ethanol
20. Synthetic fuels from biomass

Hydrogen

21. Hydrogen from renewable energy sources

This list omits many things—such as deep-ocean cooling, and sources of strategies in nature, such as the Namibian beetle—and it includes some things—such as biofuels—that I believe are highly problematic. And it doesn't mention efficiency first. But it's a useful list and an indication of many more areas of research and development. A favorite is harvesting energy from the tides.[12]

Amidst all this talk about energy, it is essential to remember that energy efficiency gains are only one part of green building and the environmental equation. Building green requires attention to results across the entire spectrum of green, including site development, efficient use of water and all other resources, indoor environmental quality, and innovation—not just energy alone. In turn, sustainable design is an integrated approach to the built environment that balances the social, economic and environmental aspects of our lives and enhances the well-being of our communities.

Now let's switch our attention to urban solutions, which are closer to the focus of this conference. Some pundits today think that cities have no future once we run out of oil. But I believe the exact opposite; dense urban clusters are the only sustainable model for a future that will see 9 billion people inhabiting the planet, all of them struggling to obtain the things they need to survive and prosper. There lots of excellent reasons why our ancestors lived in dense cities, and their reasons are still valid today.

Individual green buildings are not the answer – only the beginning. 70% of energy (and 70% of climate change) is influenced by the way our cities—including buildings and transport infrastructure—work together. Dense cities are the most energy-efficient form of habitation. A city full of green buildings has significantly reduced need for infrastructure: for power and water distribution, waste disposal, and transportation. Doubling a city's density makes it ten times more efficient.

Density has many precedents and can actually be highly attractive. Density can mean beauty as well as convenience. Density is essential to create the intellectual connections that forge human capital and spur innovation.

The city of Paris today has a third fewer residents than it did a century ago. Today it is one of the most amazing cities on the planet. It was even more so a century ago. Many people pay premium prices to holiday in cities and towns that have walkable, traditional street patterns, yet live in places that are totally automobile dependent.

[11] Claude Turmes, MEP, Vice President of The European Forum for Renewable Energy Sources (EUFORES). http://www.eufores.org/uploads/media/Claude_Turmes_-_21_renewable_energies_for_the_XXI_century.ppt

[12] although in an essay written in 1927, J.B.S. Haldane speculated that we could significantly impact the earth's rotation by harvesting too much energy from this source. *On Being the Right Size*, by J.B.S. Haldane, Oxford University Press, pg 51—64

While no doubt it sounds like pure heresy to many environmentalists, a 2004 article in the New Yorker magazine argued convincingly that,

> *By the most significant measures, New York is…one of the greenest cities in the world...Eighty-two per cent of Manhattan residents travel to work by public transit, by bicycle, or on foot. That's ten times the rate for Americans in general....The key to New York's relative environmental benignity is its extreme compactness.*[13]

The movie Blade Runner got it right, with its rich vision of new buildings layered over the old. One exception is all the vehicles flying around silently on some unknown energy system. Sure there are lots of new things to be discovered, and refinements to what we already know, but we know enough about the laws of physics today that it's kind of wishful thinking to believe that—fusion aside—there is some magic and major new source of energy that we haven't thought of yet.

So let's settle in to the business of crafting the solutions we need from the resources available to us today.

First we need to acknowledge that the earth is not for humans alone. In fact, if humans were alone on this planet we would not survive. Therefore it is critical that we preserve biodiversity, which currently is undergoing the largest extinction in the four billion year history of this planet.

One of the things this means to me is that it is a mistake to use precious agricultural land to grow fuel for automobiles, especially when their demand for fuel seems to always increase to match the supply. In turn this means that, if we want to preserve land for other species to use, it is also a major mistake to build single-story single-family houses, shopping centers and franchised retail outlets spread very thinly over our prime agricultural land.

About 45 years ago, Oregon took the simple but incredibly powerful step of drawing lines around its biggest cities and requiring them to remain within the lines. Oregon's farmers drove the initiative. As a result, when the city of Portland had grown out to the line, it turned its substantial development fervor inward and redeveloped almost every available space downtown into wonderful livable places. Portland is a city that works. This is a beautiful illustration of the Biomimicry principle "Does it tap the power of limits?" at work.

Research for Dongtan has shown that we can achieve optimal density with a mix of 3 to 8 story buildings.[14] However, taller buildings will be especially viable for a variety of reasons, including the land use issues I just discussed. They are extremely efficient users of energy, benefiting from many of the strategies I've listed.

They are particularly efficient users of transportation energy. New elevators recapture the energy on descent that was expended on ascent. The result is that a modern re-generative commercial building high-rise elevator lifts a million pounds a day for a net energy cost of a dollar an hour.[15] That's the most efficient—not to mention most convenient—transit system I've ever heard of.

People are even seriously researching vertical farming in cities,[16] and Bill McDonough is currently designing whole cities with rooftop farms (not gardens) in China.

For my money, making density attractive is the area where we need to focus significant research.

Examples of barriers (opportunities)

In preparing this presentation I developed long boring lists of barriers to sustainability. These include misguided public policies and incentives, such as:

- Building codes that are far too lax.
- Zoning codes that promote or even require unsustainable models of sprawl development.
- Transportation policies that promote and subsidize the most inefficient modes of travel possible.
- Tax codes and subsidies that reward undesirable behaviors and penalize desirable behaviors.

There are very real financial issues, such as:

[13] "Green Manhattan: Everywhere should be more like New York", by David Owen. The New Yorker, 18 October 2004. Ironically, Owen compared Rocky Mountain Institute (RMI) to Manhattan, unfavorably. RMI has a zero-energy building, but people who work there typically have to drive alone for a substantial distance to work.

[14] "Pop-Up Cities: China Builds a Bright Green Metropolis," by Douglas McGray, Wired Magazine: issue 15.05, 24 April 2007 http://www.wired.com/wired/archive/15.05/feat_popup.html

[15] George David, op cit.

[16] "Country, the City Version: Farms in the Sky Gain New Interest," by Bina Venkataraman, New York Times, Science Section, 15 July 2008 http://www.nytimes.com/2008/07/15/science/15farm.html?_r=1&oref=slogin&pagewanted

- If you can't finance an alternative, it won't get built.
- Businesses are anxious to tackle the problems that face the world today, but they require a stable investment climate. This in turn requires responsible political action now.
- Governments should use their purchasing power to drive investment in sustainable industries and power sources and water supply.
- So how are you going to buy a new place, exactly? How are you going to pay off your old mortgage so you can buy anything at all?

Removing these barriers requires a change in the finance and political worlds equivalent to what's happening in the design, construction and development communities. The good news is that, while lagging, this is happening.

We could spend a lot of time discussing each of these areas, as well as the need for better education, information, and professional development.

But a more productive approach is to look inside ourselves. The real culprit is between our ears. The human brain is the only thing that's standing between us and a more sustainable world. It's the only real barrier; all the others that we work so hard to list in great specificity are put there by this evolving gray mass.

Think about it—that's really the only thing that's causing the problem. We have known how to do a lot of these things for many, many years. And we've been debating doing them for years. Some of these things were common practice well before electricity and better living through chemistry changed the way we build.

In theory, this should be a much easier barrier to deal with. But humans have been too blind to see, or too arrogant to accept, that a massive problem exists and that we are the cause of it. It is undeniable that our actions have disrupted many of the critical natural systems on earth. Unfortunately, traditional linear thinking is deeply entrenched, and individuals and organizations resist challenges to their paradigm harder than they resist any other kind of change.

Fortunately, this same brain is also capable of solving the problem if we push it to think differently. Many years ago Einstein said, "The world we have created is a product of our thinking; it cannot be changed without changing our thinking." There is an important difference between discussing technologies and adopting technologies. The thing that's been missing is human will to make the necessary changes.

Now that it is rapidly becoming obvious to a sufficient number of people that we are "hitting the wall" and are in real trouble, people are beginning to wake up and become part of the solution. We are at the tipping point.[17] Now we may finally find the will to switch to more sustainable thinking. I believe that the solution is as simple as making that switch.

Huston Eubank is an architect with extensive experience in the sustainable design of buildings, communities and businesses. His background includes serving as Board Secretary and then Executive Director of the World Green Building Council, a Principal with the Green Development Services team at Rocky Mountain Institute, the Director of Building Futures Services for David Gottfried (the founder of the USGBC and WorldGBC), the "EarthSmart Ambassador" at Portland General Electric, and a senior project architect at Gensler. Huston has a Bachelor of Architecture degree from Cornell University. In 2004 he was named a Fulbright Senior Specialist. He is currently focused on creating a "beneficial social virus"—a radical new web-based green building community and resource that will be a highly effective tool for improving the property industry's environmental performance globally.

[17] The Tipping Point, Malcolm Gladwell, Back Bay Books, 2002)