Building Green:
Investment Opportunities in Sustainable Construction Materials

by

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B.S., Architectural Design, Massachusetts Institute of Technology
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Submitted to the Sloan School of Management and the
Department of Civil and Environmental Engineering
in the Partial Fulfillment of the Requirements for the Degrees of

Master of Science in Civil and Environmental Engineering

and

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ABSTRACT

This thesis examines the developing demand for environmental and health improvements in construction. It identifies investment opportunities which satisfy these market changes and develops a framework to analyze major green issues across top market segments.

Also called green building, this construction trend addresses four main concerns with buildings - energy efficiency, water conservation, indoor air quality, and material conservation and reuse. While all four concerns are not entirely new to the building market, the combination provides an opportunity for innovation in developing, producing, and distributing new products and services to the market.

Through an analysis of traditional construction markets, examples of model green buildings, and descriptions of major environmental and health concerns, the reader is introduced to the opportunities and barriers in this important and growing field. Subsequently, the thesis provides detailed perceptions of green building by the key decision makers in the residential, commercial, and institutional construction sectors. The four main drivers in green building are ranked in terms of growth opportunity and accompanied by specific product and service opportunities. Finally, these opportunities are analyzed for potential market size, barriers to growth, and suitability to outside investors.

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Finally, in addition to the many individuals who volunteered their time and perspectives for interviews, the building professionals at the National Association of Home Builders, the Kitsap County HBA, the Atlanta HBA, the Denver HBA, the City of Austin Green Builder Program, the Home Center Institutes, the American Institute of Architects, What's Working Consultants, Canada Mortgage and Housing Corporation and GreenVillage have all provided important resources on green building products, services, and trends.

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CHAPTER 1: INTRODUCTION

Section 1: Outlining the Hypothesis

A. An Underrecognized Market

As a broad subject, green building currently attracts little attention from the investment community, the business press, or for that matter, construction trade groups. The term tends to isolate many writers and readers who consider it one more marketing trend. Despite these reservations, however, the issues and markets behind green building do warrant attention from business interests. Issues of operations costs savings, high quality work spaces, and safe environments are important to everyone inside and outside of the building industry.

When most people think of anything "green" they think that (1) it must carry a hefty price premium and (2) it will not fit into a normal lifestyle because it looks unusual or requires extra attention. Green building, when executed well, is neither of these. It provides intelligent solutions to basic building issues. In fact, elements of green building are already on the market, and are already noted for their low-maintenance qualities, durability, and lower operating costs. One does not need to work or live in a dome house or underground building to support green building initiatives.

Green building successfully marries both real business issues and real environmental issues in a way which is accessible by almost everybody. Every employee, every family, and every company deals with buildings at some level of detail. Whether it is developing a multi-million dollar office complex or selecting a new coat of paint for a child's room, green building issues are or should be considered in the decision making process.

B. A Growing Trend

Interest in green building has seen a marked increase in the past fifteen years. Emerging from the energy conservation efforts of the late-seventies and becoming a driver in its own right in the mid-1980's, green building reached national recognition with a watershed project in 1992 by the National Audobon Society (to be discussed in further detail in Chapter 3).

Great activity in green building exists in pockets throughout the United States. In many areas, building professionals address issues of sustainability and the built environment, but three noteworthy municipalities have developed formal programs which act as inspirational models for

other cities. These regions are Austin, Texas; Boulder, Colorado; and Kitsap County, Washington.

Furthermore, top national firms in the building industry are involved: the large U.S. commercial builder, Turner Corp., and the largest U.S. architectural design firm, HOK, each have active departments specializing in the design and construction of greener buildings.

From the kernels of mainstream recognition in 1992, the issues behind green building have grown in both public awareness and project scope. Trade journals for builders, architects, and engineers regularly cover issues related to energy efficiency, water conservation, material conservation, and indoor air quality and feature recent green buildings in design reviews. Articles in home renovation magazines and cable television shows increasingly touch on issues of green building, while specialized green building journals and newsletters have developed. Finally, *The Wall Street Journal* and other major business publications feature green building issues more frequently.

C. Latent Demand

Despite initial steps toward public recognition, green building is not currently recognized as an issue in and of itself by most levels of decision makers - from the public, to distributors, to builders, and real estate agents. Most of these professionals say that neither their clients nor themselves are particularly interested in green building; many, in fact, say they are completely unfamiliar with the term. This may be partly due to a lack of time to develop recognition and partly due to barriers in the market which hinder further mass market acceptance. Despite this unfamiliarity, most parties are concerned at some level with energy usage, recycled materials, physical reactions to chemicals or water use. The lack of a unified, consistent message, though, decreases the ability for programs to reach a mass audience.

In addition, the construction industry is particularly noteworthy for the slow pace at which change occurs in the mainstream market. As discussed in Chapter 2 of this paper, the industry is highly fragmented, relies on skills and support of many unrelated decision makers and is highly influenced by government regulations.

Despite the lack of recognition currently for green building and the barriers to change within the industry, this trend has potential for investment opportunities. For one, the construction and building materials industry is very large - $700 billion - meaning the market potential for most common building materials is significant. Secondly, green building is grounded in environmental drivers which are expected to only grow in the near future. If anything, concerns with global warming, solid waste generation and natural resource conservation will become more complicated in the future.

Regulations may or may not be the major driving factors, but economics often will, given that the subject is recognized by the decision maker, and the solution is actionable.

Section 2: The Largest Market Opportunities

While green building is interesting and relevant for all construction projects and facility owners, certain market segments show greater promise than others. As an initial overview of green building this thesis will focus on only the top three markets in the segment. This does not mean that other segments are not important, but only that they seem initially less attractive for current investments. The chosen segments are homebuilding, commercial and institutional construction.

A. Homebuilding

Homebuilding is the largest market segment within the construction industry. If green building were able to capture only 10% of the new home construction market, that one segment would equal $16 billion - larger than many entire industries.

While the majority of homebuilding companies are not currently focused on green building, individual Homebuilding Associations (HBA's) have indicated interest on a regional and national level. The National Association of Homebuilders (NAHB), the largest national trade association for residential construction, started its own national Green Builder program in 1997. As an initial phase, it is co-sponsoring a local Green Builder program in Atlanta, in conjunction with the Environmental Protection Agency (EPA). The Atlanta program is at the study phase presently - developing focus groups of homeowners and homebuilders and developing the basis for a new program.

The NAHB - Atlanta program will be patterned after three existing local models. Though less than ten years old, the Austin, Texas program is considered the "grandfather" Green Builder program in the U.S. Among its many national and international accolades is a 1992 award from the United Nations Earth Summit in Rio de Janeiro as one of the twelve most innovative local environmental programs in the world.[1] The Boulder program has existed for three years and the Kitsap County program was initiated in February 1997 and as of December 1997 has enrolled 20% of all local area builders.

[1] City of Austin Green Builder Brochure.

B. Commercial Buildings

The next largest market segment consists of private sector commercial projects, includes primarily office buildings, shopping centers, and hotels and accounts for $86.7 billion. While green building in the residential market may grow through regional hubs, green building in the commercial sector will grow through a few key projects. Though this sector is significantly smaller than homebuilding, individual projects are proportionally much larger than the average homebuilding project (i.e.: One house at $300,000 is only .0002% of the $160 billion residential market, while a $300 million office complex is roughly 1% of the $28 billion office building market).

The commercial sector is expected to welcome green building because of demonstrated initial interest by a few progressive companies and a good fit with general business goals. In the last five years, several U.S. and international companies operating in the U.S. have built their own facilities with distinctive goals for environmental and health characteristics. Major headquarters, plants and support facilities have been funded by Duracell, Sony, Microsoft, The Body Shop, the Gap, Herman Miller and others. Their green buildings include such elements as non-toxic materials, energy conserving technology, and recycled materials. In addition, one speculative office building is under construction using green technologies and specifically promoting itself as environmentally friendly and health conscious. This facility, 4 Times Square, in New York City, is profiled in Chapter 4.

These buildings may promote the ethics of the owners, but they are also good business investments. Initially, the construction cost of a green building will be on-par with a traditionally built facility, or marginally higher, depending on the extent of changes to the building system. Over three to five years, however, the lower operating costs will increase the net present value (NPV) of the facility.

If the commercial owner is not impressed with operating cost savings, the benefits improved work environment should be convincing. Green buildings focus on healthy environments as well as environmentally sound structures. For the typical office-centered company, the payroll accounts for the majority of annual expenses, while building operations are generally less than 5 percent. From this, it is clear that increasing productivity, reducing sick time, and reducing turnover is a valuable tool for a company.

Healthy environments have been proven to improve all of these factors. Internationale Nederlanden Bank invested an additional $700,000 in energy efficient systems, improved ventilation and non-toxic materials when it constructed its new headquarters in 1987. The result was a $2.4 million annual

savings in energy and a 15 percent drop in absenteeism - which saved an additional $1 million.[2] In the litigious U.S. context, green buildings may also reduce the risk of liability from sick building syndrome. Finally, building a green building is a good opportunity for a company to differentiate itself from competitors - either in attracting employees or in publicizing itself to its customers.

The commercial sector, and particularly the owner-occupied sub-sector, is a good focus for green building because large commercial building owners build with such economies of scale that they are able to influence the market. The Gap, for example, has a subsidiary which develops its new stores: planned new store development in 1997 is 200 stores, with 300 more in 1998. Likewise, Dayton Hudson Corp., the largest U.S. department store chain, has a building inventory worth nearly $6 billion and spent over $300 million on construction in 1996.[3]

C. Institutional Buildings

Institutional construction is the third focus of attention for green building. This sector includes schools, universities, and hospitals - and focuses primarily on privately operated institutions. Public institutional facilities may be just as active in green building, but the bureaucracies surrounding them make change and new product introductions difficult. This difficulty is especially visible in local schools.

The institutional sector is currently experiencing a very high construction rate which makes the sector attractive, even though it is fairly small. In addition, institutions are often willing to accept longer payback periods for newer technologies which will save them operating costs in the long run. Like the commercial sector, larger institutional facilities have a lot of clout in the building industry; for example, Columbia / HCA Health Care, the large Health Maintenance Organization, operates over 330 hospitals and health facilities worth $7 billion. Its 1996 construction program contributed another $600 million to this inventory.[4]

Section 3: Lower Priority Construction Segments

While the entire construction industry is an appropriate target for green building, this thesis focuses on only the top perceived markets at this time. For space constraints, this criteria rules out other

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[2] David Malin Roodman and Nicholas Lenssen. A Building Revolution: How Ecology and Health Concerns Are Transforming Construction World Watch Institute 1995: 45.

[3] Tulacz, Gary T. "The Top Owners." ENR, November 24, 1997: 35.

[4] Tulacz, 35.

sectors which have great potential, but are slightly more complicated or mature. These sectors include both new construction and renovation and repair work.

In new construction, industrial facilities, heavy infrastructure, and public facilities were ruled out of the study. Industrial facilities have made strides in recent years in environmental aspects of their operations. Generally, these have focused on process technologies instead of building changes. Since there is still room left for advances in process work, green building may not be the most valuable focus at this point. Heavy construction (the construction of roads and bridges) uses a limited selection of materials. Of those materials, many have already pushed boundaries in terms of the recyclability of materials and other environmental factors. This segment is perceived to have little room for improvement in using green building materials.

Public facilities have also been ruled out. Product differentiation is difficult because regulations limit the specification of brand name products for federal projects. State and local governments can be more flexible, but are generally difficult and slow in response. Noteworthy exceptions exist and warrant further study in the future. Three federal agencies stand out in their green building efforts and these include: the National Park Service, the General Services Administration, and the U.S. Navy. All have initiated green builder programs in the last five years with varying levels of complexity. These programs have included specification guidelines for product selection, design guidelines and procedures for field implementation officers.

The large construction sector focusing on repair and remodeling will be discussed in a cursory fashion and mostly in contrast to new construction in the residential, commercial and industrial segments. Because decision makers, distribution channels, and products for repair and remodeling can be quite different from new construction, further research on this subject alone could yield valuable information.

Section 4: Primary Obstacles to a Growing Green Building Market

The major risk to investing in this market is the slow pace of change in the industry. This lethargy results from fragmented decision-making in design and construction, financing risk, building regulations, and the training of construction trades. In the United States, particularly, decisions in the design and construction process are highly compartmentalized. Generally, architects, engineers, general contractors and subcontractors come from different companies. In public construction, in fact, they are required by law to be independent for objectivity. Existing incentives deter parties from recommending changes that are outside of their traditional scope of work. Details of the interaction between design and construction professionals is further described in Chapter 2.

Section 5: Recommended Investment Opportunities

Given these discontinuities in the market place in general, and for green building in specific, opportunities to the investor interested in this industry include information flow, distribution, manufacturing or licensing of new products, marketing of existing products and green building construction. Depending on the skills and risk-aversion of the investor, ideal opportunities will differ.

These opportunities are discussed and prioritized in detail in Chapter 6. Initial hypotheses for improving information flow include developing a catalogue of green building products, providing inexpensive consolidated access to product information through a consortium of producers, and developing easy to understand, easy to act on information to the end-user of the building.

Distribution could be improved through consolidation of several small producers either through acquisition or formation of a consortium. Increased penetration of traditional distribution channels would increase exposure of products and availability. Also, alternatives to traditional distribution - through specialty green distributors or internet access - could provide green building materials an opportunity to circumvent traditional producers and gain an edge in future delivery. Marketing programs for both small product manufacturers and builders of all sizes will help increase the recognition and potential premium paid for green products.

Section 6: Structure of this Thesis

This thesis presents a broad overview of business opportunities in the emerging field of green building. Intended for readers who are only marginally familiar with the construction industry and associated environmental issues, a background of the industry is presented, as well as highlights of interesting trends for the future. The final result is a roughly prioritized list of investment opportunities which span the green building field.

A. Industry Background and Environmental Concerns

Chapters 2 and 3 outline the primary forces defining green building. Chapter 2, describes the structure of the traditional construction and building materials industries. This includes a summary of recent construction census data, a description of the key decision makers in each construction segment, and expected trends for the next five to ten years. An overview of the building materials

industry follows and presents the market value, business trends, top competitors, and distribution channels.

Chapter 3 provides a background on the environmental and health concerns that make green building relevant to the construction industry. This section focuses on global, regional, and personal issues. The impact of buildings on each issue is described, followed by regulations and market pressures which will continue to drive green building in the future.

B. Examples of Green Building

Chapter 4 illustrates various approaches to green building. It outlines common solutions through both building design and material specification. A range of recent projects for different types of clients is detailed to give the reader a sense of what has been done already. This tangible evidence of progressive green architecture will provide a baseline on which additional investments could build.

C. Identifying and Screening Investment Alternatives

The final section of the paper analyzes specific opportunities for business investment within the green building framework. In chapter 5, industry needs are first outlined by one of four main green building criteria - energy conservation, indoor air quality, water conservation, and material conservation and reuse. After a description of common market perceptions and approaches, each issue is mapped against the potential market segments and ranked according to high, medium, or low growth opportunities. Particularly strong sub-segments will be identified for each construction market. Once all four issues are reviewed, they are compared in the screening framework shown as Figure 1 below:

Figure 1: Screening Template for Green Building Issues and Top Markets

	Indoor Air Quality	**Energy Efficiency**	**Material Conservation/ Reuse**	**Water Conservation**
Residential				
Commercial				
Institutional				

Within each market and issue, key decision makers will be discussed with respect to their different capabilities and interests in implementing green building ideas. Specific barriers and opportunities to

each green issues build on the information provided in chapters 2 and 3 and are identified and ordered as shown in Figure 2.

Figure 2: Template of Decision Makers

Market	Decision Makers	Indoor Air Quality	
		Priority	Impact
Residential	Homeowner Homebuilder Architect Remodeler		
Commercial	Owner Executive Facility Mgr. Tenant GC Architect Developer		
Institutional	Trustee / Board Facility Manager Architect GC		

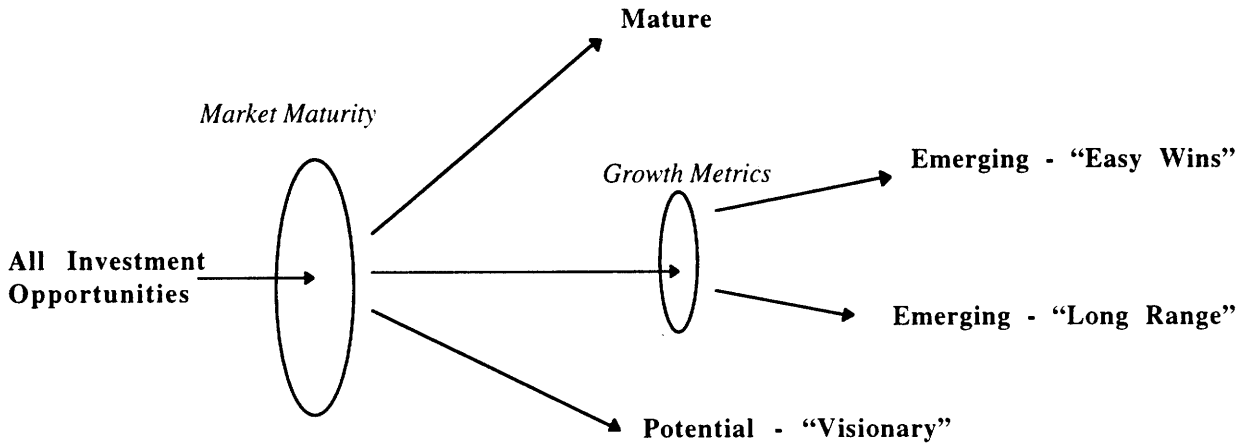
Where a decision maker is identified as having a high *priority* for a certain green building issue, this implies a personal incentive to understand and influence decisions affecting this issue. On the other hand, where the person is identified as having high *impact*, they will have both the authority and skill to influence decisions. As will be discussed, the two are rarely matched perfectly.

Following these matrices, the segment on each green issue concludes with a list of innovative product ideas to be considered for investment. Each opportunity will then be briefly described, including a description of the product, noteworthy companies in the field, market maturity, potential for market entry, and technology development.

Following the discussion by individual sections, green building will be addressed holistically. Interesting opportunities in the service industry are described as they relate to information, marketing, and construction. Details on each opportunity are listed following the same format as outlined for the four green issues.

In chapter 6, all business opportunities are screened and prioritized based on investment horizons. Figure 3 diagrams the series of screens through which each product opportunity will be analyzed - eventually arriving at four levels of investments in green building.

Figure 3: Screens for Investment Opportunities



Ideas will be screened by general market opportunities, including possible growth levels, investment horizons, and alignment of priorities with the decision makers. The ideas are then segregated into mature, emerging, and potential opportunities as defined in Figure 4 below:

Figure 4: Overall Ranking of Investment Opportunities

Mature Opportunities	Emerging Opportunities	Potential Opportunities
• Few additional technology changes in current industry. • Consolidated industry with high barriers to entry. • Existing Commercial Market	• New technology developments expected, but fairly well understood. • Fragmented industry in the process of consolidating. • Room for market entry • Commercial market development within five years	• New technology development expected, still in R&D • Totally fragmented industry • Room for market entry • Commercial market development beyond five years • No market leadership • Current market barriers to growth - cost, building codes, technologies

Mature opportunities will be applicable to investors already within a specific industry, while emerging and potential opportunities are relevant for all investors, depending on investment goals and horizons. Emerging opportunities will be most suitable for near term investors, while potential investments will be longer term and riskier. Emerging opportunities includes a wide range of products and are

further segmented into two categories - also by investment horizon. The metrics listed in Figure 5 will be used to further analyze these specific products.

Figure 5: Emerging Opportunities Analysis Metrics

- Target Market
- Replacement for existing product or new product
- Equivalent Traditional product
- Projected future market size and growth
    - Size of Equivalent Product
    - Potential Size of Green Replacement (10 %)
- Price Premium
- Opportunities for outside investors
- Fit with current construction practices
- Barriers to Growth

Based on these metrics, ideas in emerging opportunities will be roughly prioritized. Finally, where large barriers do exist to future growth, thoughts on what would need to change (ex: external regulations, product cost, building practices) to make the idea successful will be discussed.

The results of this analysis are four levels of potential investment opportunities which are accessible to a broad spectrum of investors.

CHAPTER 2: INDUSTRY BACKGROUND

Section 1: The Construction Industry

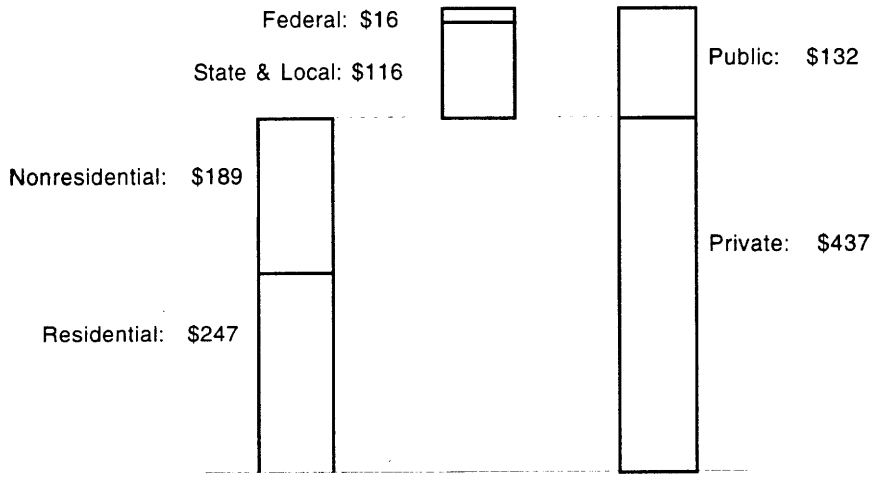
Before initiating a more thorough description of green building trends and related investment opportunities, one must first understand the market dynamics of the traditional construction and building material industries in which green building will develop. Ideal opportunities will be those which leverage current changes in the market, resolve problems beyond environmental and health issues, and appeal to multiple parties.

A. Overall Market Size

The United States is one of the leading construction markets in the world, employing 7.2 million Americans and accounting for over 7% of the Gross Domestic Product (GDP). This market size makes construction one of the largest industries in the country. The U.S. is also a net exporter of construction services, which totaled $25 billion in contract value in 1996.

The total value of new construction put in place in the U.S. equaled nearly $570 billion in 1996, an all-time record. This total can be segmented between public and private construction and further by sub-markets. As shown in Figure 6, private construction constituted the majority of spending in 1996 at $437 billion or 77% of the total and was divided into roughly 57% for residential construction and 43% for non-residential. Public construction made up only 23% of total spending and was heavily weighted toward state and local projects.

Figure 6: Total Construction Put in Place, $ billions



Source: U.S. Department of Commerce, *Value of Construction Put in Place*, July 1997.

The data presented here includes new construction and improvements for the residential market, but only new construction for all other segments. To approximate the total new and improvement market, we can use data from the more thorough 1992 census which indicated that 65% of the construction business is made up of new construction, while approximately 20% is additions and alterations, 10% is maintenance and repair, and 5% is unaccounted for[17]. This would increase the total construction market to roughly $740 billion in 1996.

Public and private construction can be segmented further by end-user:

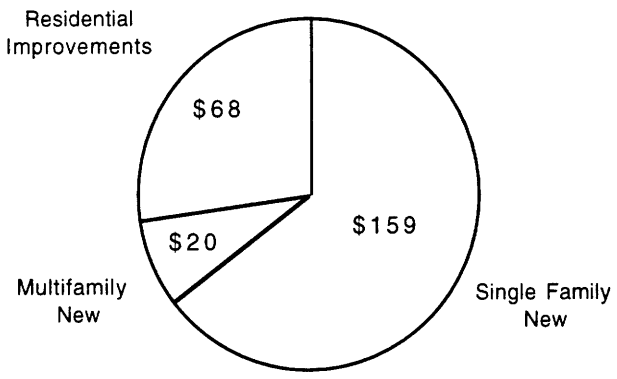
Private Construction

Residential

Private residential construction produced 1.45 million housing starts in 1996 and constituted over 43% of the dollar value in the construction industry. The single-family housing segment dominates the market, leaving multifamily housing construction at only 10% of the total. Private-sector residential construction is heavily weighted toward new construction (72% of total value put in place in 1996), but residential improvements are still significant at $68 billion. It is important to note that this tends to the low side of an estimate, because only materials and subcontracted work are counted in the renovation of owner-occupied single family homes. Labor by the owner is not included. Renovation of single-family homes is generally broken down further into roughly 60% additions and alterations and 40% maintenance and repair. Multifamily improvements, on the other hand, are primarily maintenance and repair. Though it is a small segment, multi-family construction actually spends more on repair and improvements than residential does for the same square footage. Figure 7 shows details on the residential market.

[17] U.S. Department of Commerce, "Trends in U.S. Construction , 1997 to 2001." Construction Review, March 22, 1997.

Figure 7 : Residential Construction



Source: U.S. Department of Commerce, *Value of Construction Put in Place*, July 1997.

This data does not include the $6 billion in manufactured homes shipped in 1996. Manufactured housing shipments have risen rapidly in the 1990's, from 171,000 units shipped in 1991 to 370,000 in 1996. A separate category, wood prefabricated home products, reached an all-time high of $3.2 billion in 1996. Currently, modular and panel housing manufacturers produce approximately 11 to 13 percent of the single family housing.[18] This category's share of the housing market should increase slightly as builders learn about the cost advantages of modular components and as consumers become more aware of the quality and affordability of this option.

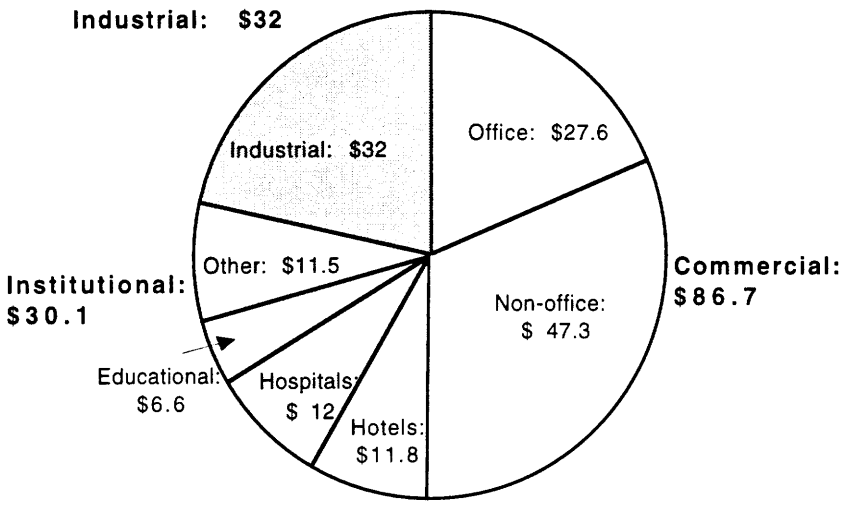
Non-residential

Private nonresidential construction includes all buildings and other structures owned by American businesses and non-profit organizations, excluding housing and mining. The gross replacement value of the private nonresidential structures that existed in 1995 was estimated at nearly $5 trillion and included manufacturing plants, office buildings, stores, hotels, hospitals, farm buildings, utilities, churches, railroads, and private schools. In 1997, the value of new private nonresidential construction is expected to be $187 billion, of which $149 billion is for buildings and $38 billion is for other structures. In addition to the $187 billion in new construction, at least $120 billion will be spent on nonresidential remodeling, repair, and other construction improvements. Exact data on this type of work, however, is very hard to track.

[18] Wendy E. Jovan and Joseph Benoy, "Industry corner: the Outlook for Manufactured Housing in the United States." Business Economics, July 1997.

As shown in Figure 8, non-residential new construction is divided loosely into commercial, institutional, and industrial work. For the purposes of this paper, commercial construction includes offices, non-office commercial (of which shopping centers compose 50 percent), and hotels. This totals $87 billion, or 46% of non-residential construction. Institutional construction includes private hospitals, private schools and religious facilities which made up $23 billion in construction in 1996. Industrial was $32 billion and public utilities were $35 billion.

Figure 8: Nonresidential Construction, $ billion



Source: U.S. Department of Commerce, *Value of Construction Put in Place*, July 1997.

Public Construction

In 1996, at only $16 billion, direct federal spending on construction was a small portion of total public expenditures. The majority of this was spent on conservation, military facilities, housing, federal office buildings, prisons, court houses, and postal facilities.

Federal capital is often passed down to state and local agencies where they are combined with local funds. This total is significant and is broken down into nine main categories. State and local government construction spending is focused on streets and highways ($36 billion - 31% of state and local total) and educational facilities ($21.5 billion - 19% of total).

B. Focus on Top Market Segments

Residential

Economics

The residential construction sector is highly fragmented for its large market size. In 1992, over 130,000 establishments were classified as residential contractors by the Bureau of the Census.[19] In addition, over 350,000 were characterized as special trade contractors. Over 100,000 establishments were counted as small builders - those with only one office, an average of 4 employees, and average annual construction work under $500,000. Large builders - those who build at least 500 units per year, have accounted for only 1 to 2 percent of home builder establishments since the 1950's though some growth in this segment has occurred recently. By sales, the top five builders make up 4.3% of the total residential market. Details on the top 10 U.S. home builders are shown in Figure 9.

Figure 9: Top Ten Builders

Company	Sales, $ mil.*	Profit Margin 1996, %*	Growth, 5-year average*, %	Return on Capital, 5 yr ave*, %	Housing Starts, 1996**
Centex Corp. / Dallas, TX	3,509	2.3	9.3	9.4	12,904
Pulte Home Corp. / Bloomfield Hills, MI	2,294	7.8	12.5	12.9	14,443
Kaufman & Broad Home Corp./ Los Angeles	1,745	def	NM	6	9,944
The Ryland Group/ Columbia, MD	1,592	def	5.5	3.6	7,867
Champion Enterprises / Auburn Hills, MI	1,588	4.3	29.4	NA	60,000‡
US Home Corp. / Houston, TX	1,182	3.6	15.5	NA	7,573
Del Webb Corp / Phoenix, AZ	1,109	def	38	2.4	5,800
NVR Inc. / McLean, VA	1,100	2.3	NM	NA	5,690
Lennar Corp / Miami, FL	1,079	7.4	24.8	8	5,795
Oakwood Homes Corp / Greensboro NC	974	7	46.4	12.2	25,351‡

Source: *Forbes, Annual Report on American Industry, January 13, 1997, p. 126-127.

**1997 Professional Builder's Annual Report of Housing's Giants.

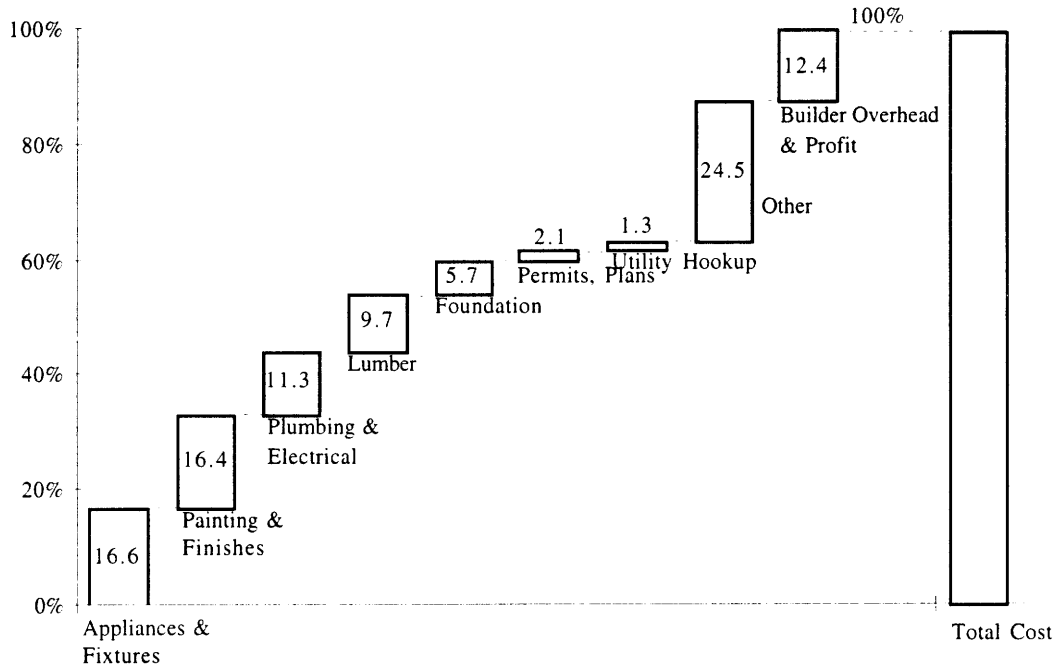
Definitions: ‡ Factory-built units; NM: Not Meaningful; NA: Not Available; def: Deficit.

Serving 65 million U.S. homeowners, residential building is challenged by low margins, easy entry and little differentiation between companies and products. As shown in Figure 10, outside factors -

[19] Ahluwalia, Gopal, "Structure of the Construction Industry", *Housing Economics,* NAHB, June 1996, p.5.

such as material prices, labor costs, and subcontractors -have a great impact on builder margins. Larger builders work from pre-designed floor plans which are repeated in a moving-factory type of assembly from site to site. All builders, and large builders particularly, are hesitant to make major product changes unless cost savings are assured and the product is well-tested.

Figure 10: Construction Cost Breakdown of the Typical House



Source: Marshall & Swift Residential Cost Handbook, 1996.

Distribution of building materials varies in the residential market both by product type and builder size. Large builders typically order commodity and bulk materials directly from the manufacturer and receive them directly on large sites or store inventory in company-owned hubs. Small builders, on the other hand, rely heavily on lumber yards to stock most materials and hold little inventory on site. Small builders, especially, expect short material lead times and often make daily trips to lumber yards to purchase individual items.

Builders as a whole are reluctant to take market risks on house characteristics and usually work with what is accepted currently. Small builders generally work without an architect, except for some custom houses where the homeowner has retained one. Large builders hire an architect on retainer or buy completed plans directly for a flat fee.

The typical house in the mid-1990's is larger than its predecessors in the 1970's and 80's and contains more amenities, but has a smaller lot. Today's average house includes 2100 square feet, 3.5

bedrooms, 2.6 bathrooms, 14.5 windows, and 3.8 exterior doors.[20] Other changes from the 1970's include a high percentage of central air conditioning in new homes, the replacement of electric heat with gas, and the use of vinyl and stucco siding instead of brick, wood, and aluminum.

Trends in Residential Construction

Residential construction is expected to grow slowly over the next five years. While new home starts will remain flat, home improvement and repair work will continue to increase at about the same rate as the GDP. Demographic factors, such as declining numbers of young adults in the prime home buying age and an increasing over-65 population will change housing needs. Individual regions - such as Atlanta, Phoenix, Austin, TX and Denver - are expected to see continued high growth. In addition, the manufactured home sector and the wood prefab industry are expected to see continued growth in to the next century with new advances in building components and Computer Aided Design (CAD) capabilities.

Broader marketing and new market entrants are also developing. Larger home builders are expanding their service offerings to include mortgage financing, pest control, security, insurance, roofing, remodeling and repair. Also, large commercial contractors are entering the market - primarily through acquisitions of mid-sized home builders.[21]

New Materials and Construction Techniques

Materials used in residential construction have changed little in recent years and 94% of single-family houses are constructed on-site using dimensional lumber. Slight increases in the use of engineered lumber (wood I-joist and open web joists) and panels (Oriented-Strand Board (OSB) and others) have emerged as has a trend toward low-maintenance exterior finishes made from composites of cement, wood, and/or plastic. The construction process has recently leaned toward premanufactured elements due to a shortage of skilled labor in this period of low national unemployment. The most common premanufactured items include pre-hung doors, roof trusses, wall panels, and stairs.

Centex Homes' model home of the future, currently under construction in Dallas, showcases the following new products from 36 sponsors and building product manufacturers: Framing with engineered wood I-joists, top plates and subfloors; roofing with OSB sheathing laminated on the underside with a new foil radiant barrier and covered with both laminated asphalt/fiberglass shingles and series-connection photovoltaic shingles. The house is wrapped in a flexible foam sheathing with

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[20] Ahluwalia, 5.

[21] Krizan, William G. and Tim Grogan. "Building Small is a Bigger Market." ENR. February 3, 1997: 36 Krizan, William G. and Tim Grogan. "Building Small is a Bigger Market." ENR. February 3, 1997: 36.

blown-in blanket insulation and R-10 triple-glazed windows. Geothermal heat pumps and energy recovery ventilators reduce energy demand, but provide more fresh air exchange than normal.[22]

Overall, the house was developed to improve quality, reduce cycle times and lower costs. This was achieved by integrating systems between manufacturers, often for the first time ever. This project points toward more systematic construction in the future which focuses on easier integration, easier assembly, and more pre-manufactured elements. Surprisingly, the builder does not market the house as green, despite the many environmentally sound features. Nevertheless, construction techniques developed by this market leader will provide a solid foundation for future innovations by even more environmentally-focused firms.

Decision Makers in Residential Construction

The decision making process for residential construction is fairly simple. For new speculative construction, home builders or residential developers make all of the direct decisions, guided by local regulations and their sense of the housing market. For the small custom built housing market, the homeowner and home builder will make decisions jointly, with occasional design assistance from a registered architect.

In home remodeling, homeowners control most decisions - either by doing the work themselves or by contracting specific tasks to a subcontractor. Nevertheless, homeowners are generally naive about the complexity of home renovation. They often do not understand the structural or system needs, even though they can easily describe a qualitative image of the finished product. Additionally, they often distrust professional builders and remodelers and rely mostly on family, friends, and neighbors for advice. Older, more experienced homeowners are best able to evaluate their needs and capabilities, are most willing to hire professionals, and generally spend more on long term investments in a house.

For the largest remodeling projects, architects, interior designers, and general contractors may be involved. In selecting building materials for renovation, homeowners have the most influence in selecting appliances, plumbing hardware, cabinets, and finishes such as paint, carpet and other floor coverings. Remodelers, on the other hand, have the largest input over window and door purchases.[23]

Residential building is also impacted by indirect influences, including building codes, neighborhood covenants, interest rates, and input from real estate agents. The skills of trades - like carpenters and

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[22] Rick Schwalsky, "Building the Home of the Future", *Builder*, National Association of Home Builders, September 1997: 150-170.
[23] Gopal Ahluwalia, "Remodeling Activity," *Housing Economics*, NAHB, May 1997, 10.

plumbers - also impact projects, because some may not know how or be willing to take on newer techniques.

In summary, green building will grow more easily if it accommodates and reinforces trends which are already taking place in the residential marketplace. These include focusing on premanufactured elements, systems integration, consolidation among large builders, and the impact of do-it-yourself homeowners. In addition, the importance of information for the homeowner and the real estate agent's primary role in gathering and explaining issues must be better addressed by the green building industry.

Commercial Construction

Economics

Characterizing commercial building is not as simple as residential construction, because of the broad range of industries covered. The size and type of structure varies considerably from project to project, as do the goals of the building owner. The design and construction of commercial buildings differ from residential in several ways: the average commercial contractor is larger (although the top contractors in both segments are of similar size); large general contractors serve both the commercial and institutional markets (see Figure 11); less of the actual construction of a facility is constructed by the general contractor and more is subcontracted (see Figure 12); projects are managed more often with sophisticated project management tools and more oversight from owners' representatives and architects; almost all projects are designed by a team of architects and engineers; and building materials have much longer ordering lead times, with the majority of materials purchased directly from the manufacturer.

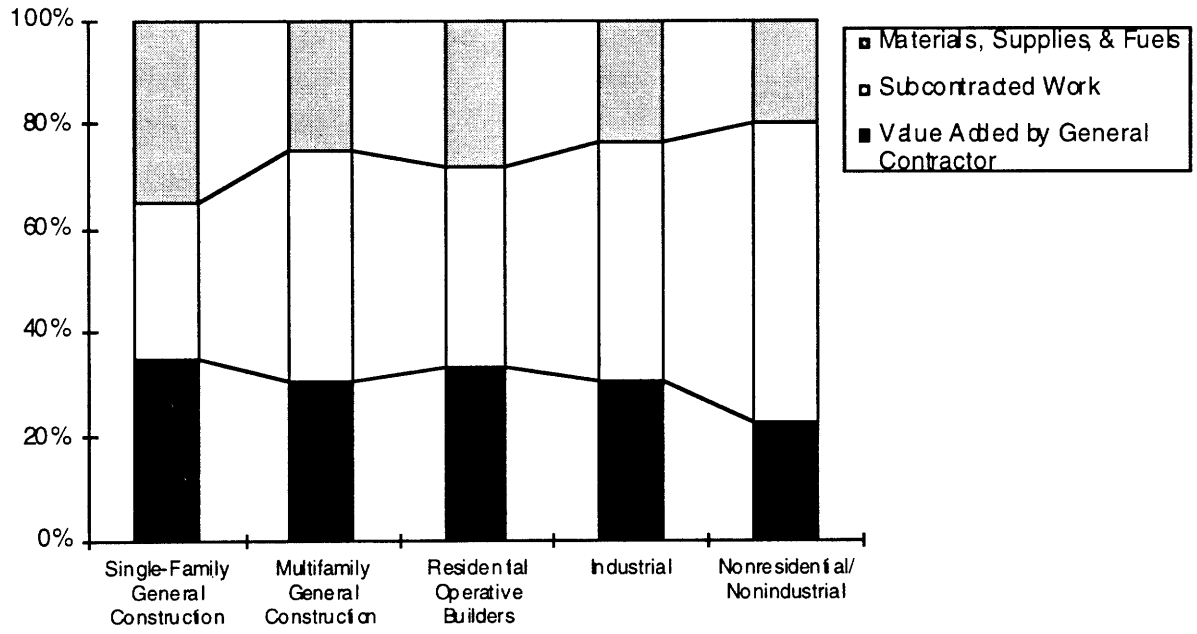
The materials are also different. Instead of dimensional lumber, steel studs are the norm. Structural steel, exterior wall panels, and flat roofs are common in commercial construction but rare in residential. Similarly, HVAC, plumbing and lighting systems are much larger and more sophisticated in commercial construction.

Figure 11: Major Commercial and Institutional Builders

Company	Sales, $ mil.	Profit Margin 1996, %	Growth, 5-year average, %	Return on Capital, 5 yr ave, %
Fluor	11,015	2.4	10.7	16.8
Foster Wheeler	3,723	1.3	10.2	8.3
Turner	3,311	def	NM	4.1
Jacobs Engineering	1,799	2.4	12.4	15.9
Perini	1,225	0.6	1.5	def
Stone & Webster	1,187	def	NM	1.4
Granite Construction	961	3.2	9.2	8.9
Apogee Enterprises	912	2.4	8.2	8.0
Butler Manufacturing	816	2.9	9.8	15.2
Forest City Enterprises	547	2.4	5.9	3.4

Source: Forbes, Annual Report on American Industry, January 13, 1997, p. 126-127.
Definitions: NM: Not Meaningful; NA: Not Available; def: Deficit.

Figure 12: Value added break down: General Contractor, Subcontractors, Materials



Source: U.S. Department of Commerce, "Census of Construction Industries," 1992.

Trends

Commercial construction is highly cyclical, particularly for new office building which experienced a dramatic boom and bust period in the 1980's and early 90's. Today, despite general oversupply in the same market, investor interest in commercial construction has been strong due to financial and regulatory developments. The advent of Real Estate Investment Trusts (REITs) will help support commercial construction, as they channel private equity into commercial real estate and provide demand for existing buildings. But a repeat of the 1980's construction frenzy is unlikely "because of tax law changes, tighter regulatory scrutiny, and greater wariness in the investment community. The recovery in the office-building cycle is likely to be slower but more sustainable than in past recoveries."[24]

In 1997, development focuses on office construction as well as industrial plants and factories. Formerly strong areas of malls and so called "big-box" stores have dropped off.[25] Modernizing the capital stock of the U.S. private sector will provide strong underlying demand for new construction as well as for repair and renovations. By 2001, private nonresidential construction will have recovered to its 1990 levels, but spending on factories, utilities, and hospitals will account for a much larger share of the total, and commercial construction will be a substantially lower proportion. Nonresidential repair and renovation markets will probably continue to grow in 1998 and for the next five years.

Although the office supply/demand situation has steadily improved, the office construction market remains burdened with fairly high vacancy rates, slower growth in white-collar employment and technology trends favoring substitution of home offices for office buildings. In many office markets prime office buildings are for sale at prices below the cost of construction. Nevertheless, a sizable amount of office construction will continue because of the availability of equity via REITs and strength in a small number of cities and market niches. The office renovation business has fared better than new office construction in recent years. In some markets, expenditures for office renovation are greater than new office construction put in place. Much of the growth in this market segment is the result of over-building during the 1980s, which compelled owners to upgrade their older buildings to remain attractive in the competitive rental markets.[26]

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[24] U.S. Department of Commerce, "Trends in U.S. Construction , 1997 to 2001", *Construction Review*, March 22, 1997.
[25] Lubove, "Annual Report on American Industry", Forbes, January 13, 1997, p. 128-129.
[26] U.S. Department of Commerce

The relationship between building owners and general contractors has become more competitive and focused less on long term relationships.[27] This is partly due to the growth of REITs which acquire portfolios of property and then either manage the daily operation of the properties themselves or contract it out. REITs also rely heavily on outside consultants to assemble their deals. The combination of outside investors and outside building managers has encouraged more short-term investment horizons than the previous developer-owners.

In contrast, the remaining building owners have become more sophisticated with facility investments. Depending on the volatility of their industry, owner-occupants have tended toward investments which require longer payback periods but reduce operating costs. In addition, some large building owners have initiated sole-source contracts for materials in an effort to improve supply chain management. This applies to the building industry in use of design-build contracts as well as in the procurement of regularly ordered finishes, like carpet and paint. For example, Compaq Computer and Blockbuster Video stores have sole source contracts with Collins & Aikman carpets where they pre-select a limited group of carpets for all stores across the country, making renovations simpler and taking advantage of economies of scale.

Although hotel construction is usually a small category of construction, it has been booming in the mid 1990's. The 1997 value of hotel construction was more than double the 1994 value, with much of this growth from casinos. Other commercial building has consisted of shopping centers (50 percent) and warehouses (25 percent). The remaining one-fourth included restaurants, gas stations, banks, fast-food restaurants and other facilities. Soft retail sales suggest slow growth in store construction in the future.

Decision makers

Decision-making in commercial construction varies by project. Usually, the architect works closely with the client and designs all of the major elements of the building - including siting, plans and sections, and general material selection. The design is then passed to structural, mechanical and electrical engineers (sometimes from different companies) who study and make recommendations for specific structural and electrical details, as well as heating, ventilating, and air conditioning (HVAC) equipment. Major changes to the architect's plans are rarely made, due to time and expense constraints. Innovative engineering systems are discouraged because the costs of failure are enormous while the rewards for success are relatively small.

Contractors usually bid for the construction phase of the project, once all plans and specifications are complete. They work directly for the client, but interact with the architect as the owner's

[27] Interview with Jim Becker, Beacon Skanska.

representative. Contractors are rarely brought into the design phase and only make slight changes to improve constructability or reduce material costs. Many contracts are awarded to the lowest bid and are fixed for the work on the plans, with changes to the original bid requiring additional compensation. Subcontractors work directly for the general contractor.

In design and construction oversight, building owner-occupants (or if not the official owner, then a large, long-term tenant) are represented by professional facility managers or by a company executive, depending on the project importance. Building owners have considerable influence over the building design and characteristics, especially when the facility managers are sophisticated. An expected payback period for most building operating elements is approximately 3 to 5 years. Smaller building tenants, in contrast, generally have limited input in building decisions and the authority only to select finishes for their interior spaces.

Like residential construction, indirect building influences include building codes, interest rates, and capabilities of trades. Current vacancy rates have a significant impact, while realtors have less influence, since the tenants are a bit more savvy and most information is disclosed early on in the building search.

For the commercial sector, green building initiatives should focus on the growing market in office renovations and possibly on a new niche market in healthy hotels. Addressing the key decision makers in large owner-occupants and REITs interested in a differentiating angle or in limiting liability will be important. Finally, opportunities exist for green building and other new market forces as part of a larger trend toward innovative construction techniques and computer-based design and procurement. The largest design/build firms as well as progressive owners are ideal supporters of green focused construction.

Institutional Construction

Economics

Large institutional clients are very similar to the owner-occupant commercial client, in that projects are sizable, they often have facility managers on staff, and the construction methods are similar. The institutional sector is significantly smaller than commercial construction at $23 billion, though institutional clients may be more willing to fund innovative construction techniques. Institutional clients also often accept longer payback periods when making building system investments. However, budgets can be more limited, restricting their risk-taking.

Trends

Clients in this category include a wide range of public and private institutions. Because of this, trends are best explained by specific building types. Institutional building is largest in the new construction of health care and educational facilities. The construction of hospitals and nursing homes totaled $10 billion in 1996, where the majority of funding supported additions and modernization of existing facilities. Seventy-five percent of health care construction is for privately owned facilities. This trend should continue, as publicly owned hospitals lag behind in facility investments. While health care construction should experience limited growth, nursing home construction is likely to increase faster because of the rapid increase in the number of elderly Americans.

Schools and libraries will experience healthy growth in new construction for the next few years due to the record number of school aged children, the backlog of school buildings in need of repair and the population expansion into under-built areas. In 1997, "more than 80 percent of educational construction expenditures were for publicly owned buildings; the rest went for privately owned buildings. Nearly 70 percent of the spending was for secondary schools, while colleges and other higher education facilities accounted for an additional 25 percent."[28]

Decision makers

Trustees and boards of directors have great impact on the building programs of institutional clients. Facility managers will make technical and less significant decisions. Institutions are also likely to bring additional experts to the design table. One notable trend is for an industrial hygienist to review the architects and engineers' design plans and dictate changes relevant to ventilation systems and finishes for reasons of indoor air quality. Indirect influences are similar to those in commercial, adding medical regulations for hospital construction and renovation.

In summary, green building should focus on the renovation and new construction of health care and educational facilities. Industry consolidation and market changes in health care will encourage an examination of real estate portfolios. Green building professionals can play a significant role in identifying opportunities to improve indoor air quality and reduce operating costs. In education, green building can play a similar role, as new schools are built and old schools are renovated to accommodate enrollment fluctuations and changing facilities needs.

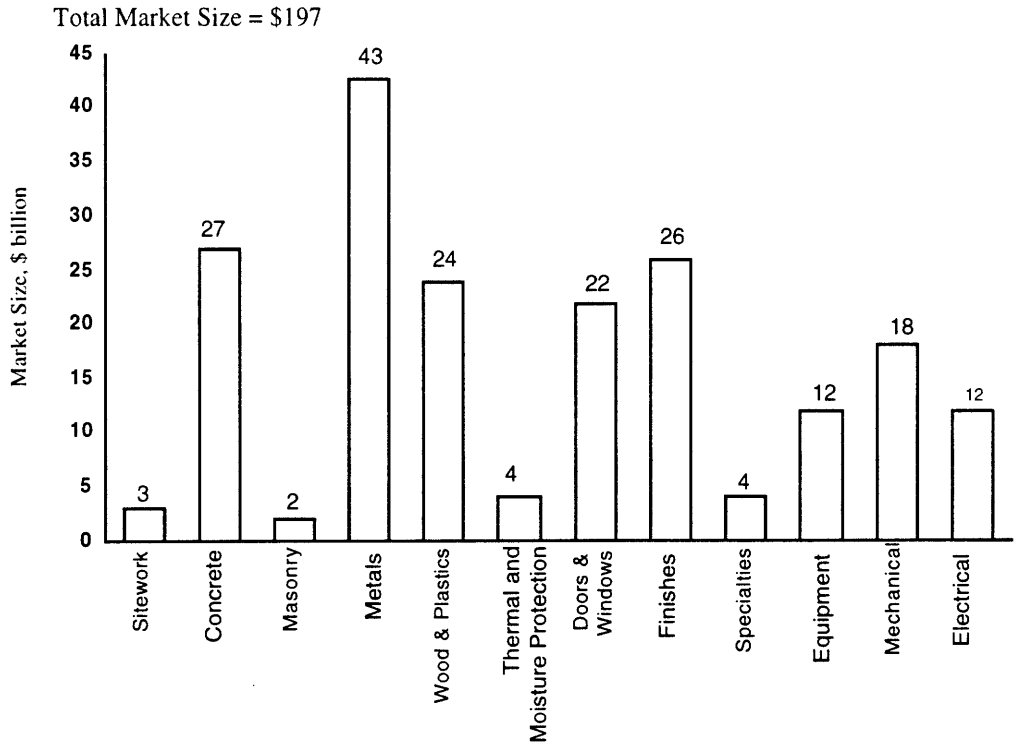
[28] U.S. Department of Commerce, Construction Economics, March 1997.

Section 2: The Building Materials Industry

The building materials industry is a difficult market to illustrate simply. Not only is it highly fragmented by product, but within product categories, manufacturing and distribution trends vary greatly. The industry consists of a range of manufacturers, from the dominant Weyerhaeuser, Owens-Corning, and USG to independent, regional concrete mixers and ceramic tile producers. Building materials include everything from tons of structural steel for a 50-story office building to a gallon of latex paint for a bedroom.

Roughly 40 percent of the total value of construction is attributed to material inputs. This leads to a U.S. building material industry of approximately $230 billion, assuming little international trade. This estimate can be born out through aggregate calculations by SIC code of individual building material calculations. As shown in Figure 13, a rough calculation by the author indicates at least a $200 billion industry. (Calculations by spreadsheet are attached in Appendix A.) The number may be lower than reality, because materials which are sold through retail outlets are not generally included.

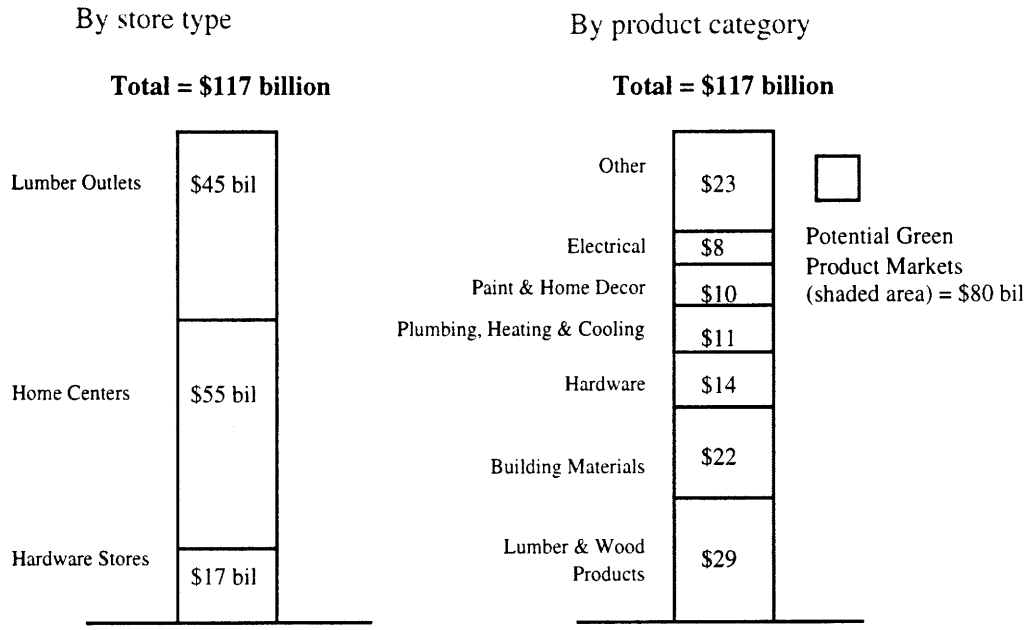
Figure 13: Building Materials Sales by SIC Code



Source: Author's Calculations using SIC Code data.

Retail distribution statistics reveal a different mix of materials and a total market value of $117 billion, as shown in Figure 14.

Figure 14: Retail Sales of Building Materials



Source: Walter Johnson. "Measuring Retail Performance." Do-It-Yourself Retailing, April 1996.

More detailed information is tracked for key building material categories. This includes lumber and wood products; drywall; roofing, siding and insulation; millwork, doors and windows; finishes; electrical products; and plumbing, heating and ventilation.

A. Lumber and Wood Products

Relative to building materials in general, lumber and wood products is a concentrated market segment. The top ten U.S. lumber producers account for over one third of all softwood output - most of which supplies the single-family construction market. These large producers are Georgia-Pacific, Weyerhaeuser, Louisiana-Pacific, Willamette, Champion, and Celotex. Industry leaders are often vertically integrated, with large timber holdings, sawmills, and distributors. Small producers exist, but are most common in niche markets like hardwood flooring, shingles, and sustainably harvested lumber.

Lumber and wood products can be further segmented into four main categories: dimensional lumber, engineered wood, sheet goods, and millwork. Dimensional lumber is a $24 billion industry at the wholesale level and currently facing two transitions. First, competition from steel studs, commonly used in commercial construction and now increasingly in residential, is forcing dimensional lumber producers to develop new products with longer spans, more consistent pricing,

and smaller tolerances. This pressure has lead to the rapid introduction of engineered lumber and paneling. The second major trend is a shift in production from government-owned Northwest forests to privately-owned Southeast forests. This trend is driven due to a combination of environmental and labor costs, as well as the degrading quality of trees in the heavily harvested forests of the Northwest.

As indicated, sheet goods and engineered wood products are experiencing solid growth. Softwood veneers and plywood constituted the largest portion of this market at $5 billion in production value in 1992. Reconstituted wood products were $3 billion and hardwood veneers and plywoods made up $2 billion.[29] Growth will continue as major producers develop new products to satisfy wider spans and heavier loads.

Several opportunities for green building products exist in this area, including the continued development of sustainably harvested lumber, reduced lumber consumption through engineered lumber, and the elimination of formaldehyde and other chemicals used in the adhesives of plywoods and particle boards.

B. Gypsum Products

Gypsum products - including wallboard, acoustical tiles, and other plaster products - are inexpensive, easy to install, and fire retardant. Forty percent of wallboard products are used in new residential construction. Another 35% for remodeling and repair and 10 % in new commercial construction. US Gypsum is the largest producer with 30% of the approximately $2.5 billion market.[30] This market is fairly stable, with few opportunities for new entrants. Opportunities for green products include an increased use of recycled gypsum and other materials in the production of wallboard. Niche producers of alternatives to gypsum wallboard are discussed further in Chapter 5.

C. Roofing, siding, and insulation

Roofing, siding, and insulation, combined here as building enclosure systems, are rarely produced by the same company. With the exception of Owens Corning which is developing a bundled package of products, a host of smaller manufacturers exist in this market.

Roofing materials are diverse - including wood and asphalt shingles as well as sheet metal and rolled felt. Similarly, manufacturers are fragmented by product type and regions. Asphalt felt and coating, a $4 billion industry, is fairly concentrated; the largest producer is Temco Inc. with $300 million in sales. The siding market, on the other hand, is highly fragmented, though large corporations - such

[29] Encyclopedia of American Industries.

as USG and Owens Corning, have relatively less presence in the industry. The vinyl siding market, a $1.3 billion market, is expected to grow 6 percent annually for the next few years. Opportunities for new entrants with green building products exist in the increasing use of recycled, durable materials and in the more long-term use of photovoltaic roofing materials.

Insulation includes the production of mineral wool for thermal and acoustical purposes and is approximately a $2 billion industry. The market is roughly split between blanket insulation and blown-in insulation. Insulation is marketed directly to homeowners, where it is often installed as part of a do-it-yourself (DIY) project. The industry is fairly concentrated, with Owens-Corning as the lead competitor. Other producers are Manville Corp, PPG Industries, and USG Corp. This is an obvious green product for its role in energy efficiency. While these products are fairly mature, niche opportunities for substitutes to fiberglass and polystyrene insulation exist.

Distribution of roofing, siding, and insulation products is fragmented with over 160 establishments in wholesale distribution and additional retail distributors. The larger independent wholesalers include American Builders and Contractors Supply Company ($300 mil. in sales) and Pacific Coast Building Products ($300 mil). Competing against them are subsidiaries of Owens-Corning and others.

D. Finishes - paint, wallcovering, carpet, and flooring

Manufacturers of interior and exterior finishes are concentrated within product types, while distribution is fragmented but gradually becoming more concentrated. Paint production is a $13 billion business, with the top four producers accounting for 30 percent of the market. Architectural coatings comprise approximately 40 percent of the total industry. DIY purchases make up two-thirds of the paint destined for this market, while professional paint contractors buy the remainder. Major producers are Sherwin Williams, Glidden, PPG, and Benjamin Moore. Green products are important to the paint industry and include recycled as well as low-toxicity products.

In retail, paint, stains and wall coverings are a concentrated industry with nineteen specialty companies and $425 million in sales.[31] These retailers target the important do-it-yourself market, where customer service and brand loyalty are important. Sherwin-Williams is a market leader, though discount stores and home centers are providing increasing competition. In contrast, the wholesale distribution of paint, stains, and wall coverings is much more fragmented and low-budget.

Carpet sales saw a ten-year growth trend during the 1980's and then trailing demand in the 1990's. Frequent mergers and acquisitions have consolidated the market, leaving Shaw industries as the top

[30] Encyclopedia of American Industries.
[31] Encyclopedia of American Industries.

producer with $3 billion in sales. The residential market is the top segment and is split roughly 55 percent for remodeling and 45 percent for new construction.[32] Several environmentally-oriented producers exist in this market and focus on use of recycled raw materials.

E. Millwork, Doors and Windows

Millwork production, which includes decorative trim, stairs, cabinets, windows and doors made from wood, is a $10 billion industry and includes 2000 large and small producers who sell through a variety of distribution channels. Residential construction utilizes more than 60 percent of millwork. Trade patterns in millwork have undergone considerable change recently due to environmental pressures and the reduction of trade barriers. Future industry changes will come from the increasing use of premanufactured components and resulting trends toward consolidation.

While the production of wood trim and cabinets is extremely fragmented, the manufacture of windows and doors is fairly concentrated. The privately-owned Anderson Corp. is the leading window and door manufacturer in the industry. It promotes its products through high-profile marketing to both builders and home buyers. Sales of $900 million and continued market strength are possible through economies of scale and the production of standard size products. Other leading companies include Marvin Lumber and Cedar Co. ($280 million in sales), Trus Joist International, Jeld-Wen, Huttig Sash, and Pella. Wholesale and retail distribution is mixed. Independent dealers stock windows and doors by specific manufacturers. Increasingly, these products are being carried at home centers and national lumberyard chains. For green products, energy efficient windows are a fairly mature market, while millwork products which conserve wood or use recycled materials have growth potential.

F. Electrical Products

Electrical products are segmented by end product use. Residential light fixtures are a $1.7 billion, highly fragmented industry. Commercial, industrial, and institutional lighting is a $3.4 billion market and is also fragmented. Overall, office buildings are the largest market segment. The market for light bulbs is $3 billion in the U.S., and $9 billion internationally.

The wholesale distribution of electrical products is a $16 billion fragmented market. Wholesalers face decreasing market share as manufacturers sell directly to home centers and large hardware stores.

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[32] Encyclopedia of American Industries.

Wholesalers have responded by improving store efficiency and adding custom and maintenance services. The market leader is Grainger with $2 billion in diversified sales.

G. Plumbing, heating, air conditioning and ventilation

Plumbing manufacturing consists of fixtures, fittings, piping, and vitreous china. This market exceeds $3 billion and has seen steady growth in the last decade. Renewed interests in home renovation and a trend toward larger bathrooms have produced consistent eight percent growth rates. Fixtures and china are somewhat consolidated, with competition from larger companies, such as American Standard, Kohler, Masco / Delta, and Moen. In comparison, the manufacture of piping and fittings is fragmented, with no true market leaders. Product changes include water-saving devices, such as aerators and restrictors, and more distinctive designs. Distribution is also currently fragmented, though increased pressure from home centers is broadening distribution channels from previously exclusive sales to contractors and plumbers.

The $2 billion U.S. heating market includes low-pressure boilers, radiators, supplemental heaters, solar heaters and fireplaces. Despite intensive consolidation efforts during the 1980s, this industry remains highly fragmented. The majority of producers employ fewer than 300 workers. The largest producer of heating equipment is Amtrol Inc. of Rhode Island, with $150 million in sales. While the industry as a whole has grown little, individual products - such as gas-powered equipment, residential baseboards and radiant flooring, and solar domestic hot-water heaters have seen growth in the 1990s. Low energy prices, however, continue to dilute opportunities for sales growth of high-tech, energy efficient products. This, in turn, will minimize opportunities for technological break-throughs and high replacement sales.

Ventilation and air conditioning were heavily influenced by external regulatory and market changes in the last decade. Concern over sick building syndrome, air borne particulates, and the emission of ozone depleting substances caused great concern in the industry. This regulation put pressure on new technology development, but in the early 1990s, the fear of products becoming obsolete caused the industry to stagnate while alternative refrigerants and other technologies were researched. Nevertheless, European advances have encouraged a greater systems approach which considers heating, ventilation, humidification, and air cleaning jointly. Integration of these systems with lighting, security, and entertainment systems will be important in the future, as will the development of smaller, quieter equipment. In the commercial sector, the use of thermal storage to take advantage of off-peak energy rates will grow.

The HVAC industry is sizable with over $60 billion in sales worldwide and over $20 billion in the United States. The market leader in HVAC equipment is Carrier Corp. which held an 11 percent

worldwide market share in 1995. Other large producers include ASI Holding Corp. and York International, each with over $1 billion in sales.

H. The Building Materials Industry and Green Building Implications

In summary, the building materials industry is highly fragmented, with only a few notable market leaders. The above list of industries will be referred to again in chapters 5 and 6 when specific green products are analyzed in more detail. For the moment, however, the reader should note the diversity of products, technologies, customer segments and market sizes. While each industry leaves room for innovation, some are more mature than others. Similarly, some are better suited for outside investment than others. On an even larger scale, aspects of the market are ripe for consolidation. These market changes provide an opportunity for green building.

Section 3: Distribution of Building Materials

While most manufacturers focus on one of the above product categories, retail distributors cover a range of products. This segment has traditionally been cleanly divided into three categories: 1) wholesalers which supplied very large contractors and retailers, 2) lumber yards which supplied medium and small contractors, and 3) hardware stores which catered to individuals. This started to change dramatically in the 1980's when Home Depot introduced the warehouse home center concept which provided an unusually broad range of products at low prices. The initial marketing targeted the DIY homeowner but has grown to include small and medium home builders. In the process, the industry value chain has consolidated with wholesalers, lumberyards, and hardware stores losing market share.

Home Depot currently defines the market with 589 stores producing $19.5 billion dollars in sales - or 14 percent of the $138 billion home improvement industry. Other top competitors include Lowe's and Sears Orchard Hardware. As the race toward consolidation continues, two versions of home maintenance retail will emerge: the warehouse stores focused on contractor sales and serious DIY customers and the upscale home decorator store. Home Depot and Lowe's will try to fill both needs, while Sears' will concentrate on the home decorator. These leaders will also expand product lines and concentrate more on imports and international expansion. In the next ten to fifteen years, a handful of large home centers will serve all but the largest home builders. Commercial and institutional contractors will continue to be served by wholesalers, with potential in-roads by direct sales from the manufacturer via the internet.

The change in distribution channels will dramatically affect how green building products and services develop. Before recent changes, the independent lumberyard provided customized service to local

market needs. Information and ordering of niche products which fit local demands would be available for the small home builder. The larger home centers provide financing services and low cost products which the lumberyards can not meet, but home centers are less tolerant of small manufacturers. Their national distribution systems rely on national supply, price pressures on manufacturers, and just-in-time delivery. Often the niche, environmental firm has difficulty fulfilling these requirements and is left out of this important channel. Additionally, Home Depot requires third party verification of environmental claims - an expensive hurdle for small companies. To survive and grow, these producers must learn to meet the demands of Home Depot and others, or they must define an equally successful alternative to the home center. Ideas on this subject are discussed further in Chapters 5 and 6.

Section 4: How Green Building Products work within this framework

Industry economics have great impact on the growth potential and investment alternatives for green building. As outlined in the opening hypothesis, this influence includes obstacles as well as opportunities for new products and services.

A. Barriers to Market Growth

New product development in the construction industry faces barriers such as customer switching costs, lack of training by the construction trades, and retaliation from existing competitors. Circumstances faced by green products add to this list the challenges of developing customer awareness, gaining credibility, and communicating information.

Customer Switching Costs

In the construction industry, switching costs to new materials are high for builders and general contractors in all sectors. Margins are limited and the risks of material failure are often higher than the potential rewards of innovative design and construction. Among contractors, residential builders have the most control over material selection because they make their own design decisions and subcontract relatively little construction work. Residential builders, however, also have little market power and few resources to analyze new products and techniques. Low economies of scale mean they have little impact on decisions by manufacturers and distributors. Their clients are extremely price conscious and generally unaware of green building initiatives.

External factors reinforce these switching costs. Financial and insurance institutions may delay projects for fear of resale problems or liabilities from building failure. Because these institutions

rarely have technical staff to evaluate the characteristics of the building, they look for comparable projects which have been successful in both quality and resale value. Without such a comparable, requirements for owner equity in the project may be increased along with interest rates.

Lack of Trade Training

An indirect barrier affecting both commercial and residential sectors is the lack of training among construction trade groups installing the green building products. For instance, more than 90% of single-family residential construction is based on a standard series of tasks centered around 16" on-center framing with dimensional lumber and 4' by 8' plywood sheets. Carpenters, plumbers, electricians, HVAC contractors, and sheet rock crews all know how to work around this format. Changes lead to complications, delays, and cost over-runs. Both residential and commercial contractors have few full-time employees, making training of the constant shuffle of craftsmen costly and time-consuming. Even if the contractor were able overcome these hurdles, conservative building inspectors could still limit the range of opportunities available to new building techniques and materials.

Dominant Competitors

The building products industry, itself, poses some hurdles. While the industry does not face anything like the giants who control some industries, several companies are large enough to discourage the small start-up - either through existing market share or through influence over building code development. Most green building products are replacements to existing components. While this may allow contractors to substitute one material for another and cut costs in the process, the new product must reach the shelves of the distributor and displace the traditional equivalent before it can be selected by the builder.

The small green products manufacturers that survive are often limited in their regional distribution and in marketing scope. Their green building claims are not verified by third parties, because these fees are too costly, and thus a limiting cycle is developed which forces green building products into a niche market.

Developing Consumer Awareness

Two recent surveys of home builders and home buyers by the National Association of Home Builders indicated that both groups favor environmental qualities in residential construction. When asked to rank green issues against other buying factors, however, the traditional drivers of price, location, size, and aesthetics heavily outweighed a concern for the environment. Moreover, the homeowners' perception of environmental priorities was often far different than that of green building

professionals; large wooded lots, energy efficient appliances and open space were top priorities, while radon resistant construction, alternative products to wood, and solar heating received little interest. Thirty-eight percent of builders said buyers never ask about environmental features while 51 percent said home buyers seldom ask. In addition, 77 percent of builders said they have never built and are not planning to build sustainable housing developments, despite the majority thinking that a label as an environmental builder is good. Additional information on the NAHB study is included in Appendix B.

Less market research has been conducted on environmental decisions in the commercial and institutional sectors, though many of the same drivers would apply. The commercial and institutional sectors are more attractive to the green building market in some respects because these decision makers have access to information resources through the architects, engineers, facility managers, and contract managers who regularly work on large projects.

Gaining Credibility

Even converted green builders need verification that the products they specify have the true recycled, non-toxic, or energy efficient attributes advertised by manufacturers. While the niche group of green builders may be willing to gather this information independently, the average consumer does not have the time or knowledge to verify environmental attributes. For this reason, a trustworthy, standardized labeling system - such as those used on nutrition labels or seals used to designated recycled paper - is needed.

Communicating Information

Once credibility concerns are assuaged, information is needed at all stages of building - for the end-user, the design professional and the contractor. This includes informing the mass market on the benefits of building green; it also includes providing details on product description and local availability

B. Opportunities

Opportunities to grow the industry develop out of solutions to these barriers. Typical construction industry hurdles, such as material switching costs can be reduced by limiting the risks of product failure and by changing product characteristics to better fit common building methods. Long term warranties - such as the unprecedented fifty year warranty by HardiPlank, a recycled composite siding manufacturer - reduce the liability concerns that discourage home builders from trying new products. The result was a successful product which grew quickly beyond niche markets. Similarly, designing new products to accommodate traditional construction practices eases the transition from

old products to new. Examples are plastic lumber which can be nailed, cut and stained just like exterior grade lumber and photovoltaic shingles which are installed in a similar fashion to standard asphalt shingles. Finally, improving design expertise through bundled solutions or consulting for resource constrained builders help improve green building initiatives over the long term.

Small green building material producers can compete more effectively with the strong distribution channels and large market share of national producer through industry consolidation, marketing partnerships, and licensing arrangements. Increased size and scope promise improved access to the efficient distribution channels of home centers as well as the effective development of alternative distribution channels. Both are necessary to reach beyond current niche markets.

As in traditional building, consumer awareness is generated through model home shows, advertising, magazines, and word of mouth. Similarly, information on green products can be presented in many formats - from traditional home decorating magazines, to green-focused real estate agents, to environmental journals and web pages. Currently, Green Builder programs in several cities are lowering some of these hurdles with rating programs and guidelines for different levels of environmental construction. A brochure for one such program in Austin is included in Appendix C.

Green building credibility is being addressed through relatively new third party testers, such as Green Seal and Scientific Certification Systems (SCS) in the United States and Green Dot and Ecomark abroad. ISO 14000 certification has been developed for international standardization. In addition, building product industry groups have developed self-rating standards. The carpet industry, for one, has begun a testing and labeling program to respond to public concern over indoor air quality. Individual carpet lines that do not exceed established levels of certain emissions are awarded a green and white Carpet and Rug Institute Testing Program label.

The chapters that follow present more detailed examples of companies that have responded successfully to these industry hurdles. The dynamic nature of the industry means that more challenges - and corresponding opportunities - will develop as the market grows.

CHAPTER 3: THE ENVIRONMENT, THE BUILDING SECTOR, AND THE CONSTRUCTION INDUSTRY

This chapter presents a broad overview of major environmental issues and focuses on how the building industry (specifically within the U.S.) contributes to environmental and health concerns. Expected trends for the future, including market and regulatory influences, are summarized for each major issue.

Section 1: Lifecycle Impacts of Buildings

Buildings have a significant, but often under-recognized impact on health and the environment. In order to produce, distribute, use and demolish building materials, environmental- and health-related decisions are made daily. The production of traditional building materials requires first the mining or harvesting of raw materials such as gypsum, lumber, oil, and stone. This mining consumes natural resources and impacts the quality of the surrounding land. Manufacturing consumes energy and uses clean water and air to refine the raw materials into standard building elements. The by-products of this manufacturing are often air and water pollution, along with solid waste generation. Materials are then distributed to the building site. Depending on the nature of the material, the product may be hauled less than 100 miles from the manufacturing site, as in cast-in place concrete, or it may be shipped half way around the world like tropical woods, decorative ceramics, small motors and plumbing fixtures. Construction operations themselves use energy and the manipulation of building materials emit particulates and chemical fumes which impact worker health.

The static use of building materials, as components of a larger structure, also has a large impact on the environment and the health of the general population. During the long life of a building, materials are often repaired, altered, or removed as part of a renovation. During this phase, the release of new chemicals and particles can create health problems. Likewise, the removal of used building materials creates a stream of solid waste which is generally incinerated or discarded in landfills.

A joint publication by the American Institute of Architects and the Environmental Protection Agency, *The Environmental Resource Guide*, analyses the life cycle environmental impacts of common building materials. Intended as a guide for architects to make sound decisions, this resource is also useful for the potential investor in reviewing new products or identifying environmental problems with old products. Selections from the 1997 issue have been included in Appendix D.

With this holistic view of building materials in mind, the following chapter outlines the major elements of environmental and health issues associated with the building stock and the construction industry. Key themes are segregated into global, regional and personal issues, though there is much overlap between issues.

Section 2: Global Issues

Global environmental concerns are dominated by threats of global warming, ozone depletion, and a loss of biodiversity.

A. Global Warming

Simplistically, global warming is created when gases in the atmosphere insulate the earth and prevent some of the sun's heat from escaping into space. This is a natural effect without which the world would be frozen. But industrialization and agricultural development have resulted in increases in the concentration of some atmospheric gases and consequently trapped more heat. The result is a slight, but important, increase in the earth's surface temperature - estimated by the Intergovernmental Panel on Climate Change (IPCC) to be a 0.2 degree Celsius change per decade since 1975. At our current rate of greenhouse gas production, this would result in a temperature increase of 1 to 2 Celsius by the year 2050. This seemingly small increase is thought by some experts to lead to rising sea levels, changing regional climatic patterns, and an increase in the severity of normal storms.

Of all human activities that contribute to increased concentrations of greenhouse gases in the atmosphere, fossil fuel combustion is by far the largest, accounting for almost 60% of the greenhouse warming resulting from anthropogenic sources in recent years. The burning of carbon-based fuel has increased the level of CO_2 in the atmosphere by 30% since pre-industrial times. Additional greenhouse gases are methane, ozone, nitrous oxide, water vapor, and chlorofluorocarbons.

Despite efforts to encourage energy conservation following the energy crisis in the 1970's, U.S. oil consumption is now the highest since 1979. With approximately 5 percent of the world's population, the U.S. creates 25 percent of the 7 billion tons of carbon dioxide emitted to the atmosphere each

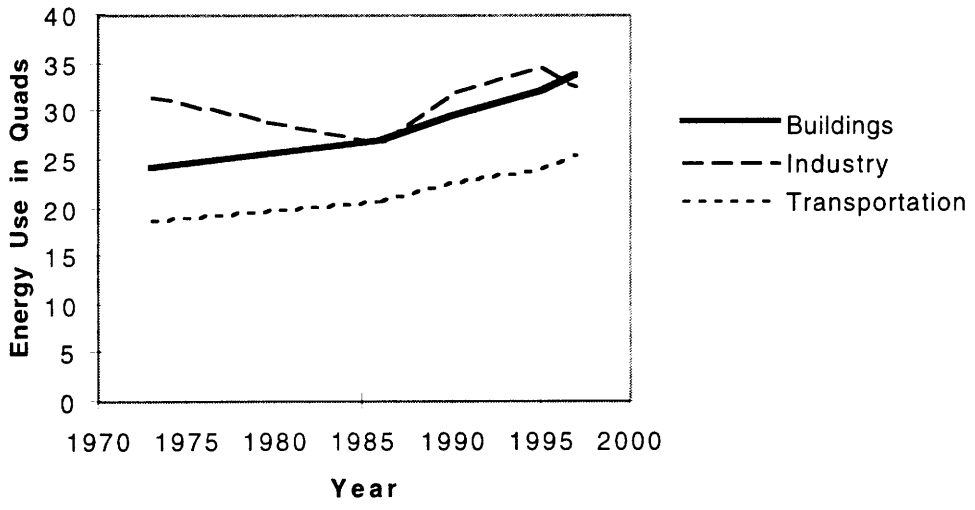
year. In order to eliminate, or at least slow, the development of global warming, it is necessary to reduce the consumption of this traditional fuel source.

The influence of the building industry

The top three consumers of energy in the United States are buildings, industry, and transportation. While total energy consumption has increased slightly, energy use by buildings has increased more rapidly than the other two sectors, because innovations and pressure to improve energy efficiency have not been as strong.

Counting simple building operations (and not construction operations or the production and distribution of building materials), the building sector is the largest user of energy in the U.S. and the largest producer of carbon emissions.[1] (See Figure 15) The cost of delivering all energy services in buildings will be over $220 billion in 1997[2] The top energy consuming operations in buildings include lighting, heating and cooling, refrigeration, and electricity for equipment, appliances, and electronics.

Figure 15: Energy Comparison between Industry, Buildings, and Transportation



Source: Energy Information Administration cited by Scenarios of U.S. Carbon Reductions. p. 2.12

[1] DOE, "Scenarios of U.S. Carbon Reductions: Potential Impacts of Energy Technologies by 2010 and Beyond"; Prepared by the Interlaboratory Working Group on Energy -Efficient and Low-Carbon Technologies, 2.12.
[2] DOE, "Scenarios of U.S. Carbon Reductions," 3.1.

In addition, energy consumption varies between building types. As detailed in Figure 16, residential energy consumption exceeds that of the commercial sector, but relies less on electricity. When considering the total stock of buildings, however, the commercial sector consumes more energy per square foot than residential construction.

Figure 16: Energy Consumption in Building Segments

Energy Use	Electricity (Quads)	Fossil Fuels (Quads)	Total
Residential (1997)	11.9	7.2	19.1
Commercial (1997)	10.6	4	14.6

Source: Scenarios of U.S. Carbon Reductions, 3.4.

Factors Affecting the Industry

Existing factors include regulations as well as incentives. Building codes dictate insulation requirements while local utilities encourage energy efficient equipment through occasional subsidies and rebate programs. Information on energy use is required for appliance manufacturers and residential sales in some states. Despite these efforts, the low cost of energy has driven few consumers to actively reduce energy consumption in their buildings.

Emerging factors may reduce energy consumption - once initial hurdles are overcome. Traditionally monopolistic, electric and gas utilities are in the process of deregulation, allowing competition across regions and between generators, distributors, and service providers. This deregulation may initially encourage more energy consumption as electricity prices decrease with more competition. As the industry restructures, however, new technologies and billing methods may encourage consumers to think more carefully about energy use. The introduction of real-time energy monitoring - which records energy consumption by the minute, not by the month, will become more common in homes as well as small commercial buildings. With this information, utilities would be able to price discriminate by time of day to discourage inefficient energy consumption at peak times.

Even more progressive utility programs encourage net-metering: where buildings owners install solar and other alternative energy systems and then trade energy with the local utility. At mid-day, when the solar system creates excess energy, the utility is usually experiencing excess demand. The building will then sell its excess energy to the utility and receive a credit which it would in turn draw

against at night when the solar system does not produce energy and the utility has excess capacity. Overall, this system will allow the utility to produce energy more efficiently and increase the aggregate production of sustainable fuel sources.

Other emerging factors for energy consumption include building rating programs such as the newly developed LEEDS program, coordinated by the U.S. Green Building Council. Federal programs, like the Million Roofs program, also encourage the installation of solar systems through subsidies for private construction and mandates for federal buildings. Finally, international pressure to reduce worldwide carbon production weighs heavily on the United States.

In December 1997, over 150 nations met in Kyoto, Japan and agreed to cut greenhouse gas emissions. In the period from 2008 to 2012, the agreement would require industrialized nations to reduce emissions below 1990 levels, a 7 percent reduction for the United States. U.S. action, however, is subject to ratification by Congress. High level, well-funded debate is expected for 1998 and U.S. industry leaders are split on what course the nation should take.

B. Ozone Depleting substances

Ozone occurs in the stratosphere, the zone 12 to 50 km above the surface of the earth, and forms a protective shield against potentially dangerous ultraviolet radiation from the sun. If the ozone layer thins or breaks, more ultra-violet (UV) rays reach the earth's surface, causing two main adverse effects. Excessive UV radiation leads to a rapid increase in skin cancer in humans and also retards the growth rate of plankton in the oceans which slows the earth's reproductive rate. Additional theories point toward stunted crop growth and suppressed immune systems.

Ozone in the atmosphere is broken down naturally by UV rays, but this process is accelerated by the presence of chlorine and other compounds, which destroy ozone molecules. Before, current restrictions, chlorine was released into the atmosphere at alarming levels through the breakdown of chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFC) which were commonly used as refrigerants, propellants and solvents and as blowing agents for plastic foams. Relatively quick reaction by international governments after the discovery of the ozone holes over the Antarctic and Arctic led to the Montreal Protocol in 1989 and the beginning of a phase out of CFCs , HCFCs, and Halon (used in fire fighting systems). New products have developed alternatives to CFCs and are currently being incorporated into the building industry. Nevertheless, the transition was not easy.

Use in the building sector

Before phase out, buildings accounted for approximately half the use of CFCs and Halon, which meant that building decisions significantly influenced the elimination of these chemicals. Most CFC and HCFC use in buildings was part of an air conditioning system, however many building components were also made using these compounds. CFCs were used in rigid polyurethane and extruded polystyrene foams, both of which were common materials in insulation, floor and wall panels.

Though substitutes to CFCs have been created by the chemical industry, designers, engineers, contractors, and building owners should weigh the reliance on these chemicals against alternative systems for insulating and cooling buildings. A better choice may be to consider switching materials and designs entirely. Well designed natural ventilation and improved heat pumps could replace air conditioning in some parts of the country. Similarly, alternative insulation and rigid panels made from mineral fiber, cotton, or recycled paper could replace the rigid polyurethane and expanded polystyrene.

C. Loss of biodiversity

Biodiversity describes the wealth of habitats, species and genes that coexist on earth in a complicated and interrelated system. This dynamic balance is normally resistant to climatic cycles and destructive natural events, however the introduction of resource harvesting and development by humans have increasingly interrupted this balance and in so doing threatened the wider eco-system. Biodiversity adds richness and beauty to our lives, but it is also essential in crop production, the development of new medicines, and the planet's ability to adapt to changing conditions. Genetic variety is essential in reacting to unknown future shocks.

The building industry's involvement

Although biodiversity encompasses a broad spectrum of issues, for the construction industry the most recognized issue is the unsustainable harvesting of timber from biologically rich rain forests and old-growth temperate forests. For example, between the early '60s and the mid-80s, tropical deforestation removed 3/4 of a billion acres of forest.[3] Much of the demand for tropical and old-growth wood comes from the construction industry where this lumber is used for decorative trims as well as large structural elements. New rating systems and sustainably managed forests have provided

[3] Rain Forest Coalition Web Page.

alternative sources of precious woods, while builders and architects are learning to specify more common or quickly reproduced species.

In addition to these concerns, however, architects and builders must be aware of decisions that affect the diversity of plants and wildlife around buildings and communities. For example, the preservation of open spaces, wetlands, and wild grasslands help preserve local eco-systems. Buildings owners can do much to maintain the existing habitats of wildlife, as well as creating new ones in and around their facilities.

Factors affecting the industry

In December 1993, the Convention on Biodiversity from the Rio Summit was entered into force. The goal of the Convention was to provide guidance and incentives for countries to protect their natural resources through national policies and legislation. The Convention requires nations to set up national programs which monitor and develop sustainable uses of biodiversity. While the United States is the only industrialized country not to sign the Convention, it has continued to develop natural resource laws to protect forests, waterways and other natural habitats within its boundaries. The use of timberlands most affects the U.S. construction industry.

Rating systems and sustainably harvested forests have seen solid growth recently as building owners, architects, and contractors specify green certified lumber. As of late 1997, 9.3 million acres of certified forest worldwide, including 1.6 million acres in the U.S., serve U.S., European and Japanese markets. (This compares to 483 million commercial acres of timberland in the United States.) Though it remains a niche market, both supply and demand are growing. Demand is particularly strong in Germany where green-certified wood has a 2% share of the hardwood flooring market and 50% annual growth in demand.[4] Large new tracts of land are being certified in the U.S., including public forests in Massachusetts, Pennsylvania, and Minnesota. None of the major private producers, however, have become certified.

SmartWood, a nonprofit program developed by the Rainforest Coalition, was founded in 1989 as the world's first certifying organization. It was followed soon after by the for-profit Scientific Certification Systems (SCS) and two European equivalents. Certification involves annual inspections of tree harvesting patterns and wildlife habitat programs, among other issues.[5]

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[4] Neil Ulman, "A Maine Forest Firm Prospers by Earning Eco-Friendly Label", The Wall Street Journal, November 26, 1997: p.A1.

[5] Wilson, Alex and Nadav Malin, "Sustainably Harvested Lumber." Environmental Building News. November, 1997: 1.

Section 3: Regional & Local Issues

A. Destruction of natural resources: forests, waterways, habitats

Directly related to the global issue of biodiversity, the destruction of natural resources impacts the regional and local community economically and aesthetically. Natural resources such as forests and waterways provide raw materials, food, and clean water which support local industry. In addition to destroying the habitat of numerous species, the unsustainable use and harvesting of lumber depletes the country's forest stock. Already, the loss of old-growth timber means smaller, lower quality dimensional lumber than existed in the U.S. several decades ago.

The use of open land, waterways, and other natural resources also affect the quality of life in the community. Stable land values depend on access to clean water, attractive recreational areas and surrounding country.

Impact on the building industry

The construction industry, and particularly the residential sector, depends heavily on lumber and wood products for new construction. The United States consumes 48.1 billion board feet (BF) of lumber each year. Of this, 14.6 billion BF is used by for single-family homes and 2.1 billion BF for multifamily development.[6] In total, residential construction accounts for over one third of U.S. lumber consumption. Specifically, the average single-family home uses 13,396 BF of lumber along with 10,912 BF of 3/8" structural panels such as oriented strand board and plywood. For homes which used only light-frame construction and no alternatives to dimensional lumber - such as concrete, steel, or I-joists - the lumber usage was even higher - nearly 15,000 BF. This consumption is the equivalent of clear cutting one acre of forest.

Industry changes

The construction industry has begun to change traditional material usage in reaction to declining lumber supplies. For one, unstable sources of lumber impact the cost of a house dramatically, as commodity prices shift widely with changes in supply and demand. For example, limited supplies of quality lumber affected wholesale prices from 1995 to 1996, increasing the cost of lumber for a single-family home by more than $3000.[7] Builders reacted to this by substituting engineered wood

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[6] Darin Lowder and Will Biddle, "How much Lumber in a House", *Housing Economics*, National Association of Home Builders, April 1997: 9.
[7] Lowder, 10.

for dimensional lumber, increasing 2x4 spacing from 16 inches on-center to 24, and using more prefabricated components which reduce waste. Specifically, the use of wood I-joists in floors increased from 4% of floor systems in 1988 to 20% in 1994. The use of prefabricated stairs, trusses, and wall panels have increased dramatically, as well, in the last decade.

B. Municipal / Solid waste

The average American creates 4.5 pounds of waste each day - a national total of over 160 million tons each year - and roughly twice as much per person as the Western Europeans or Japanese. Despite well-recognized garbage crises, however, waste generation is not slowing. In many areas of the U.S., space for landfill sites is simply running out. Existing sites are full and there is little room for expansion, especially with common "not-in-my-backyard" responses to the issue.

Even when there is available space, disposing of solid waste is environmentally challenging. Landfills do a poor job of decomposing wastes due to interior anaerobic conditions. They also contain contaminants, such as metals or toxic chemicals, that eventually leach out into the surrounding soil and water table. Alternatives to landfills include incineration and dumping at sea, but neither is as smart as reducing the waste disposal requirements from the outset.

Currently, technology exists to recycle 80 percent of waste generated in the U.S. today. Unfortunately, low tipping fees and inexpensive raw materials make much recycling uneconomical. In the big picture, though, recycling not only reduces waste and saves resources, but it also cuts energy consumption and pollution. Paper recycling can reduce air pollutants by 75% and water pollution by 67%; using scrap steel and iron rather than ore results in an 86% reduction in water pollution. Recycling aluminum saves 95% of the energy used to produce it from ore. The benefits from avoided pollution and energy consumption, however, have not yet improved the fate of potentially recycled materials. Additional market or regulatory pressures are needed to create a sustainable cycle of reuse.

Involvement of the building industry

Construction creates waste; approximately 2000 pounds of waste lumber - or 10 percent of the total lumber per project - are generated from each new single-family house built in the United States. Unfortunately, this is only a portion of the bulky solid waste. Overall, the biggest contributors to the construction waste stream are lumber and manufactured wood products (35%), drywall (15%), and masonry material (12%). The remainder is a mix of roofing materials, metals, plaster, plastics, textiles, glass, and, especially, cardboard packaging. Of the above materials, only structural steel, copper piping and a few other materials are regularly segregated for recycling. This is due to the

general experience that tipping fees for mixed waste are lower than the labor required to sort the waste materials.

The lack of recycling interest is important in both the disposal of construction waste as well as the selection of construction materials. Construction is an ideal sink of recycled waste; construction materials require large material inputs and have long cycle times before being returned to the waste stream. In addition, construction materials made from recycled material are being developed regularly and many of these products are more durable, have the same or lower prices than similar traditional materials, and are occasionally less toxic.

Factors affecting the industry

Slowly, economic and regulatory factors are driving change in the construction industry's approach to recycling. First, tipping fees are increasing dramatically in some areas as populations grow and nearby landfill space diminishes. Communities constrained by urban development, mountains or large bodies of water are particularly hard hit, as the transportation fees for waste are extremely high relative to tipping fees.

Communities are responding with mandatory recycling programs, increased tipping fees, and regulations banning certain wastes - such as drywall - entirely. For example, Kitsap County, Washington's newly formed Green Builder program was catalyzed by a threat of increased tipping fees. The local home builders association was concerned that the cost for disposal of construction waste would triple if the local landfill closed and waste haulers were forced to cross a range of mountains to the next available landfill. Similarly, the base level of the Austin, TX Green Builder program requires some form of job site recycling and the use of materials containing recycled inputs is an important aspect of the program. Additionally, built-in recycling containers and composting bins are elements of the Austin program, to encourage home buyers to recycle their waste.

C. Clean drinking water

The availability of clean, fresh water is necessary for all communities. Yet as crucial it is to our survival, the supply of unpolluted water is finite. The Earth's water is 97% salty, and a majority of the fresh water is stored in glaciers and polar caps. Most of the freshwater that we depend on is provided from rainfall gathered in local rivers, lakes and aquifers. All of these are susceptible to overuse in both our need for fresh water and our disposal of wastewater and solid wastes.

The unsustainable use of fresh water is an issue in many parts of the country. Growing urban populations in desert climates have tapped natural resources and drawn local waterways below natural levels. In addition, the deteriorating condition of municipal water and wastewater treatment plants

around the country mean that water is not being processed as effectively as could be and much water is being lost in the process.

Involvement of the Building Industry

To be able to meet current and future demands, immediate improvements are needed in techniques for conserving, collecting, storing, treating and reusing fresh water. Installing water-saving fixtures is an easy and inexpensive response to these problems; it also provides payback periods under two years. The installation of new low-flush toilets, faucet aerators, efficient shower heads, and efficient appliances can cut water use by 30%, saving an average of $100 per household each year.[8]

In addition to reducing water usage upfront, new techniques are under development for treating and reusing wastewater. Many municipal wastewater treatment facilities are deteriorated and under capacity due to a lack of upgrades and maintenance. Alternatives to municipal treatment or as a pretreatment for commercial and industrial sites are gaining interest. These include biological sewage treatment where wastewater is allowed to flow through a series of developed wetlands where it is purified by plants and microorganisms.

A simpler version of wastewater reuse is the installation of gray water systems. These involve additional piping which takes soapy and slightly dirty water from sinks, showers, dishwashers, and laundries and channels this water for reuse in the toilet or for landscaping. Many plumbing codes have not allowed the use of gray water because of concerns for sanitary conditions, but this is changing. California, for one, has instituted new codes for gray water permitting.

Factors affecting the industry

The National Plumbing Products Efficiency Act (NPPEA) was signed into law in 1992, as part of the Comprehensive National Energy Policy Act. This regulates water usage in toilets, shower heads, and faucets and developed guidelines for all new construction and repair to install 1.6 gallon per flush toilets instead of 3.5 gpf. Many local building codes have mandated this change. Unfortunately, many consumers are unsatisfied with the operations of the new low-flow models and avoid replacement of existing fixtures.

Water and sewer rates also affect industry reactions to water conservation. Water has traditionally been cheap, but recently water and sewer rates have been increasing in many urban communities. Boston, for example, has some of the most expensive water in the country and utility calculations

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[8] Laura Zeiher, The Ecology of Architecture: 121.

expect the rates to increase even more in the future. At what point this will drive more consumer awareness of conservation is uncertain, but the increasing rates will surely be a catalyst.

Section 4: Personal Health

Health-related concerns are thought by some to be outside of green building because it is not specifically focused on the larger environment. Most literature and practitioners, however, include it in their dialogue. Personal health is an issue for construction workers who must work around hazardous substances and particulates from building materials. Likewise, it impacts the building occupants who are exposed to an interior environment for many hours each day. The EPA has consistently ranked indoor air pollution among the top five environmental risks to public health.

The average American spends 80 to 90 percent of their time indoors and 65 percent of that time is spent at home. This, combined with tighter building construction and the growing use of synthetic materials, solvents and mechanical systems means that we are exposed to more chemicals and other threats to our health than ever before. The period from 1970 to the present saw an increase in inoperable windows, energy efficient houses, wall-to-wall synthetic carpet, particle board, and central heat and air systems. At the same time, chemically-formulated cleaners, personal care products and pesticides were rapidly growing in popularity. As a result, our exposure to indoor air pollutants - volatile organic compounds (VOCs), mold, and particulates - is believed to have increased. Studies by the Environmental Protection Agency show that human exposure to air pollutants are often 2 - 5 times higher than outdoor levels - and occasionally more than 100 times greater.[9]

Health problems related to indoor environments are one of the most common environmental health issues faced by clinicians.[10] Although not tied only to this issue, allergies and asthma rates in children and adults have climbed steadily during the last few decades. Today, one out of every three people suffers from allergies and an estimated one out of every six suffers from poor indoor air quality. In addition, an estimated 12.4 million Americans suffer from asthma, including 4.2 million children. Children are particularly at risk because they breathe 50 percent more air per pound of body weight than adults do.[11]

About a decade ago, the term sick building syndrome was coined to describe the condition where people become ill simply by occupying a particular building. The symptoms - irritated eyes,

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[9] EPA Indoor Air Quality Home Page, Environmental Protection Agency, Dec. 1997.
[10] Carrie Redlich, Judy Sparer, and Mark Cullen, "Sick-Building Syndrome", The Lancet, Yale Occupational and Environmental Medicine Program, Yale University School of Medicine, April 5, 1997.
[11] "Indoor Air Quality in the Home", National Safety Council Web Page, June 18, 1997.

headache, nausea, stress, sore throats, asthma attacks, drowsiness, etc. - may cause only minor discomfort in some, while causing genuine distress in others. Sick Building Syndrome is generally seen as a problem caused by a combination of factors such as poor thermal, visual and aural comfort conditions, the presence of gaseous pollutants, microbiological contamination, dust, and tobacco smoke. Symptoms, however, are often easily confused with viral or bacterial infections, making it difficult to determine an exact cause. In addition, there are thousands of pollutant sources in indoor environments, albeit at levels which should not be harmful to people. The concern often arises with multiple chemical sensitivity in which the combination of several contaminants or the repeated exposure can cause a reaction which would not have been expected from each chemical alone. A list of common indoor air pollutants is included in Appendix E.

The Commonwealth of Massachusetts Registry of Motor Vehicles became a highly publicized example of sick building syndrome a few years ago when some five hundred employees complained of similar symptoms upon moving into their newly constructed building. The Registry soon afterward moved out of the building, leaving the developer to cover operating expenses. The building received national media coverage and a long standing suit followed between several parties involved with the project.

Indoor air quality is a very new field which is not completely defined or accepted in the science and medical communities. There is no simple definition of what is "acceptable" air quality. Architects and contractors have few guidelines to follow when developing buildings. Regulations and the fear of litigation have forced indoor air quality to the top of the list of green building issues. Lawyers specializing in this field have predicted that indoor air quality claims may become the new large-scale toxic tort. Potential at risk claims include 30 percent of the nations 4.5 million office and public buildings, affecting upwards of 100 million Americans.[12]

Material producers have responded by providing material safety data sheets (MSDS's) during distribution, though often this is not enough. Unfortunately for the designer and material specifier, the rate of chemical "off-gassing" by certain materials is often not available. This hinders decision making and increases the risk of litigation to the architect and engineer on the project, as well as the building owner once the building is occupied. Because of this, industrial hygienists are increasingly being retained as part of the design team to specify materials. The result in the building industry is a need for better information, building substitution alternatives, objective analysis of building products, and better design tools.

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[12] David Governo and Eileen Kavanagh, "Indoor Environmental Claims: Air Quality", Mealey's Emerging Toxic Torts, March 31, 1997.

Section 5: Summary

As will be discussed in the following chapters, green building addresses all of the environmental and health issues mentioned here. All green building elements, however, are not the same. Each building project targets different goals. In addition, each of the four main green building issues - energy efficiency, water conservation, material reuse and conservation, and indoor air quality - have reached different levels of market maturity. Some, like water conservation and energy efficiency have been addressed by the mainstream construction industry for decades. While there may be room for growth in particular products, fewer opportunities exist for new industry entrants. On the other hand, indoor air quality and material reuse and conservation are relatively new and uncharted. In Chapter 5, we will see that indoor air quality has the best chances for growth across all markets. Energy efficiency and material reuse are good investment opportunities for specific niche markets, while water conservation shows little promise for growth.

CHAPTER 4: GREEN BUILDING EXAMPLES

Section 1: Defining Green Building

Green building is a rather new term for a collection of environmental and health concerns that have existed for decades. The term, itself, is developing and changing as more practitioners use it and as the concerns are defined. Projects described as green building generally focus on minimizing negative environmental impacts of the construction process, but can also include improving personal health within the building as well as influencing the larger affects of community development.

At the broadest level, green building includes holistic approaches to community design which encourage sustainable practices in both the construction of facilities, as well as the lifestyle of the community. In the form of New Urbanist communities, this may incorporate pedestrian- and bicycle-friendly developments which preserve natural open spaces. In the form of co-housing, it may reduce the total amount of space constructed, operated, heated and cooled by the community through shared spaces. Or it may focus primarily on creating a closed loop for recycled products, without changing current community living patterns. Simply, green building is still developing and loosely used by the design and construction communities.

Several recent design books have wrestled with the issues mentioned above and provided insight for architects and builders on sustainable community development. For the purposes of this paper, however, green building will address the construction and operation of individual buildings. Specifically, this will focus on the aspects of green building which at first-cut are most tangible and ready for business investments. This focus will identify products and services which address four main issues: energy conservation, water conservation, indoor air quality, and material conservation and reuse. These issues cover a wide range of environmental, health and operating cost concerns, and are discussed at length in this chapter as well as Chapters 5 and 6.

The first of four issues, energy conservation, is seeing a gradual re-birth after the rise and fall of the oil crisis in the 1970's. Despite the lack of a current crisis, it is still important as both an operating cost and as a significant environmental issue attributed to global warming. The motivations behind energy conservation include lowering building utility costs and reducing CO_2 emissions which result from the burning of fossil fuels. Energy conservation is usually addressed by reducing energy needs through more efficient equipment and better insulation, substituting cleaner fossil fuels for dirtier fuels, and producing alternative energy.

Water conservation measures concentrate on both the use and discharge of water, by reducing the amount of potable water consumed through daily operations and then reducing the quantity and quality of wastewater treatment required. The common solution involves replacing plumbing fixtures with more efficient products. Additional options include gathering rainwater for personal consumption, pretreating wastewater before sending it to a municipal station, and discharging wastewater into alternative septic systems or on-site ponds for natural chemical breakdown.

Material conservation and reuse focuses on the sustainable use of raw materials by reducing the amount of material used in total, as well as replacing new material with recycled material. Alternatives to reducing solid waste generation are also concerns as communities face over-flowing landfills. Products include sustainably harvested lumber, composite panels made from recycled newspapers, and reused wood, steel and masonry.

Indoor air quality is related more to personal health and well-being than larger environmental issues, but nevertheless, it is usually included as one of the major tenants in green building. Improvements to the indoor environment can involve simple changes in air temperature, lighting, and air exchange, but it can also move several steps beyond that in eliminating chemicals in the air and surrounding materials which produce varying levels of discomfort in building occupants.

In thinking about these four categories, it is important to remember that these issues are not independent; solving one problem often exacerbates another. For example, the trade-off between material conservation and indoor air quality can be complicated. Oriented Strand Board and other engineered products made from wood particles reduce the use of virgin lumber, but they can also increase exposure to chemicals which are used in the adhesives to bind the wood fibers together. A similar trade-off exists with indoor air quality and energy conservation: Enlarging air handling equipment to increase air circulation often increases energy consumption, as well. Green building issues are not always this divisive, but simplistic application of individual ideas can negate well-intended decisions.

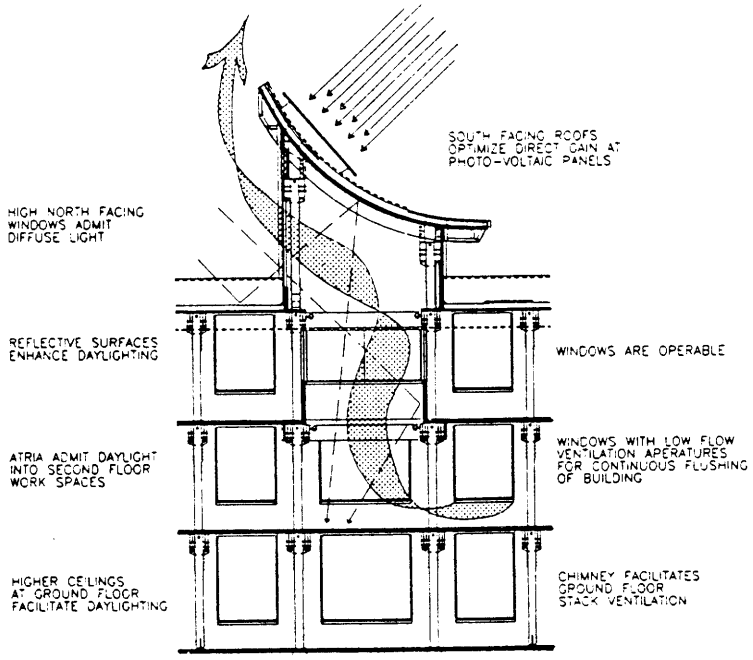
Section 2: Approaches to Green Building

Green building can be approached from two related points: building design and material selection. Both are essential elements in design and construction, but they yield different results and present distinct challenges. Applying green building principles to design is often the most elegant and effective approach, because small decisions can create significant impacts on energy conservation and indoor air quality. A well designed building can reduce the need for expensive HVAC, lighting and monitoring systems, and produce lower operating costs. While design changes may be the most effective way to approach green building, it can also be the most difficult - because it requires a well-trained designer and a willing client to study the entire building up-front. Residential builders who

apply pre-designed building designs to a variety of sites and climates lose many of the passive solar and ventilation gains of a green building design. Similarly, on large commercial projects, the segregated decision making between architect, engineers, and contractors can complicate the implementation of non-traditional projects. Despite these challenges, design decisions are simpler with new construction. With repair and remodeling projects, restricted structural and site changes limit environmental design alternatives and make green building initiatives even more complex.

Where green building design decisions are made, the most common elements are siting, ventilation, roof overhangs, building size, and daylighting. Siting the large sides of the building to face toward or away from the sun and prevailing breezes can dramatically affect the indoor temperature of a structure. Passive solar design techniques - including south-facing windows and deep overhangs - have been used for centuries to capture warmth when the winter sun is low in the sky and shade a room when the summer sun is high. Siting, combined with design changes - like wrap-around porches, cupolas, and wind-scoops can increase the natural flow of air through a building, simultaneously improving the exchange of fresh air and cooling the space. The selection and location of windows and sky-lights can increase the amount of daylight flooding a room and reduce the need for artificial light during the day. A drawing of a building section demonstrates how these elements work together (Figure 17).

Figure 17: Green Building Design Elements



Source: Matsuzaki Wright Architects, C.K. Choi Building for the Institute of Asian Research, as cited in The Ecology of Architecture, 33.

Material selection decisions can be easier to implement when designs are predetermined or when the site or building function does not allow ideal green designs. In this case, a range of traditional and newly developed materials meet the green building needs of architects, builders, and building owners.

While material selection is less complicated to implement than design, it is still not simple. Many builders and architects note that evaluating green building alternatives is daunting. Traditional materials can be compared based on any number of factors, including the amount of energy used to produce the material, quality and quantity of raw materials used, durability of the final product, insulating qualities and other metrics. To make the decision process more complicated, new materials are rapidly being developed, including recycled materials, energy efficient lighting and mechanical systems, and non-toxic materials.

Section 3: Brief Case Examples in the United States

Given the nascent qualities of green building, a few key examples may be the most effective window to the nature of this market. For this, I have selected a range of projects built in North America during the last five years which represent a range of client types.

Example 1: National Audubon Society Headquarters[1]

Client Type: Non-profit
Type of Work: Complete renovation of an existing office building
Location: New York, New York
Date of Completion: 1992
Cost of Construction: $13,900,000; $143 per Square Foot

The headquarters for the National Audubon Society is recognized as one of the watershed projects in green building. It set a new national standard for the environmentally sensitive workspace and developed successful models for resource conservation, energy efficiency, and indoor air quality. It provided some of the first performance records, specialized data, and strategies for cost and energy savings from which future commercial building owners and designers can work.

As a remodeling project, material selection features are more common than design changes. Several new types of building materials were highlighted in this project. Instead of plywood and gypsum, panels made from recycled newspaper content were installed as sub-floors and interior partitions.

[1] Zeiher, 182.

Floor tiles were made from recycled glass and countertops from recycled plastic. Wall insulation made from a CFC-free cementitious foam augmented existing building insulation along with low-E 2-layer windows. Finish materials were selected that did not release toxic chemicals. This included carpets and carpet padding that were made from 100% natural material (wool and jute, respectively) and no-VOC paint. HVAC systems were analyzed using a program from the DOE and gas-fired heating / air conditioning units were installed because they are energy efficient and CFC-free. Wiring for rooftop solar panels was also installed, so that this change could be made easily when payback periods decline. Finally, an occupancy sensor system was installed to provide lighting only where needed.

Design features in the National Audubon Society headquarters include ceiling shapes which bounce light evenly throughout the offices and interconnecting stairs along southern windows which allow natural light to permeate the center of the building. Accessible stairs also decrease the need for elevators, saving energy in the process. Special chutes were incorporated into staff lounges to provide central collection of and food scraps for composting and of paper, bottles, and aluminum for recycling. An aerobic (air ventilated) composting unit was installed in the basement of the facility.

Example 2: 4 Times Square[2] [3]

Client Type: Speculative commercial developer
Type of Work: New construction - office building
Location: New York, New York
Date of Completion: late 1998-early 1999
Cost of Construction: $500 million (estimated)

A highly visible "integration of ecology and real estate,"[4] 4 Times Square (also called the Conde Naste Building) is a 48-story, 1.6 million square foot office building developed by the Durst Organization and currently under construction in New York. It was the first multi-tenant, commercial skyscraper to use design techniques and material choices demonstrated by the Audubon Society and other green building leaders. The structure of the building is similar to that of other traditional office buildings, yet the construction practices, interior design, and HVAC and energy systems set it apart from its peers. While the construction cost was 5-7 percent more expensive than traditional projects, the developers estimate that energy savings and other benefits will provide a payback in three to five years. The facility was 80% leased early in construction and received much press attention for its distinctive features.

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[2] Clifford Pearson, "Developer Brings Green Ideas to the Spec Market", Architectural Record, June 1997.
[3] John Hadley, "The Green Light; Tower May Signal Go-Ahead for Environmentally Sensitive Construction" Chicago Tribune August 10, 1997.

To increase the comfort and effectiveness of building occupants, the design emphasized natural daylighting and improved ventilation throughout the building. The building includes air quality monitors as well as a special system which can flush three floors simultaneously with 100 percent outside air - drawn from high elevations to avoid street-level pollution. Interior design guidelines and product information are distributed to tenants to encourage energy efficient interior systems and non-toxic materials.

Innovative uses of energy products include photovoltaic cells in spandrel panels on all sides of the building which will provide 1.5% of base energy needs. In addition, natural gas fuel cells will be mounted on the roof for the majority of energy needs. Low-E glazed windows and extra-thick exterior wall insulation add to the building's energy efficiency.

Recycling was encouraged at all stages of the building life-cycle. The construction site follows a material salvage and recycling program for demolished materials and construction waste. When finished, additional trash chutes on each floor will feed automated recycling systems.

Example 3: Body Shop U.S. Headquarters[5]

Client Type: Owner-occupied commercial
Type of Work: Renovation of an existing facility
Location: Wake Forest, North Carolina
Date of Completion: 1993
Cost of Construction: $2.1 million, $21 per square foot for office spaces, $11 per square foot in the warehouse.

In 1993, The Body Shop, a cosmetics producer and retailer well-know for socially conscious business practices, decided to relocate its U.S. headquarters from New Jersey to North Carolina. In the process, company executives settled on renovating an existing office building and warehouse rather than constructing a new facility.

The plans called to reuse as much of the structure as possible, while improving energy efficiency, lighting, and ventilation. Existing heating and cooling units were refurbished and piping for the future installation of solar water pre-heating units. Skylights were added and the ceilings were painted with highly reflective white paint, to reduce the need for artificial light, while existing energy

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[4] William Browning of the Rocky Mountain Institute as Quoted by John Handley in "The Green Light" Chicago Tribune, August 10, 1997.
[5] Zeiher, 130-137.

efficient light fixtures were cleaned and maintained. No-VOC paint was specified throughout the facility. To promote resource conservation, much of the new floor tiles and carpeting were made from recycled materials. In addition, salvaged materials were reused, donated to the local Habitat for Humanity, or separated for recycling.

Example 4: Dewees Island - Reeves' House[6]

Client Type: Housing development
Type of Work: New construction - greenfield community development
Location: Dewees Island, SC
Date of Completion: 1995
Cost of Construction: $127 per Square Foot

This 1200-acre island near Charleston, SC was sparsely developed before 1992, when a state-approved master plan was designed to build a residential community on the island, while maintaining the natural coastal environment and a 350-acre wildlife sanctuary. The master plan includes extensive design guidelines and regulates the building process to minimize damage to the island. The final development will include 150 houses on 225 acres of land. The island is only accessible by boat and transportation on the island is limited to electric-powered carts and foot-traffic.

The Reeves' residence addresses energy efficiency, water conservation, indoor air quality, and material reuse. It is sited and designed to avoid direct southern sun and to take advantage of cross-ventilation from coastal breezes. A closed-loop geothermal HVAC system was installed as were energy-efficient, low water usage appliances. The local utility analyzed the energy consumption as well as proper sealing, caulking and weatherproofing of the house and provided a $1650 subsidy based on expected energy savings.

Because of specific allergy sensitivities, a powerful central vacuum system was installed. Carpeting was avoided and only non-VOC and low-VOC paints were used throughout the house. Resource conservation was addressed through the use of HardiPlank pressed concrete siding, recycled finger-jointed wood exterior trim, TREX decking (a durable plastic and wood chip composite exterior deck) and cotton batt insulation made from cotton mill scraps.

[6] Zeiher, 208-219.

Example 5: Cambridge Cohousing[7] [8]

Client Type: Urban infill, residential, partially speculative, partially pre-sold
Type of Work: New construction of 41 private apartments and shared facilities
Location: Cambridge, MA
Date of Completion: 1998 (anticipated)
Cost of Construction: approximately $100/SF

Cambridge Cohousing is under construction on a 1.6 acre former industrial site in Cambridge, MA, near Porter Square. The buildings are clustered around a series of walkways and communal facilities to encourage community activities and preserve green spaces. Green building methods are a high priority and focus on both design and building material selection. Building systems were selected to work efficiently together as well as with the natural environment. All buildings are sited to take full advantage of passive solar heat - both in the buildings and in the outdoor gathering spaces. Building materials were carefully chosen to decrease environmental impact, to conserve energy, and to protect human health. The developers eliminated or reduced the use of materials that emit greenhouse gases, ozone depleting chemicals, toxins, or carcinogens.

Important environmental features include a modular construction process that takes advantage of scale economies, factory quality control, and weather protected construction to produce units that cost less to build and are more durable and tightly constructed than traditional alternatives. This method increases energy efficiency and decreases construction waste. Efforts to conserve virgin material include wood flooring made from only sustainably harvested lumber, clapboard siding made from a durable cement and recycled cellulose product, open web joists in place of solid dimensional lumber, cellulose insulation made from recycled newsprint, ceramic tiles made from recycled glass, and flooring made from recycled tires, natural linoleum, slate, and quarry tile.

In addition to the tight construction, high-efficiency Pella windows were selected with R-3 insulation value. A centralized, state-of-the-art heating and cooling system with a ground source heat pump was installed instead of separate HVAC units. The heat pump also preheats a centralized hot water boiler, which uses small recirculating pumps to keep hot water circulating on demand. Independent room thermostats give occupants greater control and avoid heating and cooling unoccupied rooms. Finally, high efficiency water appliances and light fixtures were used throughout the development.

Indoor Air Quality was addressed with a highly efficient mechanical ventilation system with controlled air regulators, allowing a fresh air supply to each room and a central exhaust to the outdoors. This system improves air quality significantly without much additional energy load.

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[7] Cambridge Cohousing Promotional Literature.
[8] Interview with developer.

Example 6: Harmony Resorts[9]

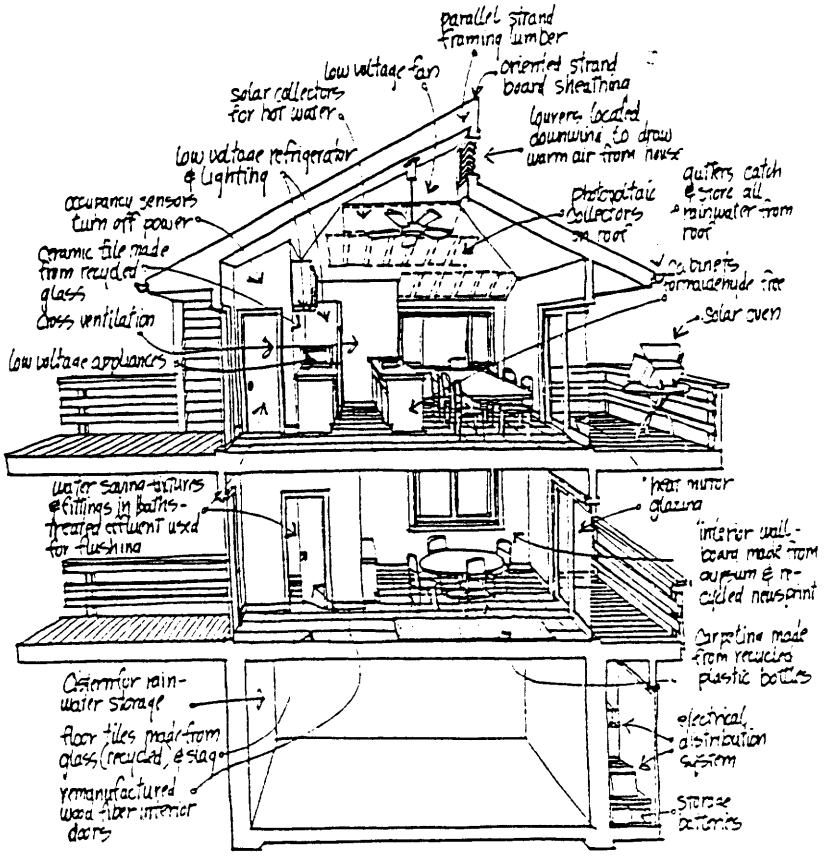
Client Type: Private resort
Type of Work: New construction of six guest buildings
Location: St. John, Virgin Islands
Date of Completion: 1993
Cost of Construction: $80,000 per unit, $190 per square foot

Harmony resorts, a leader in the "eco-tourism" concept, began its first development twenty years ago, as a joint project between the National Park Service and the resort's private developer. The initial construction consisted of 114 three-room platform tents which were carefully laid out on a hill overlooking Maho Bay within the National Park. The tents and connecting walkways were constructed on stilts so as not to disturb the surrounding plant and wildlife. In addition, recycled materials were specified where available and solar energy was used to make the resort entirely independently powered.

To build on the success of the platform tents, the developer sought to build a less rustic, but equally green, addition to Maho Bay. A design workshop was sponsored with representatives from the American Institute of Architects, the America Society of Landscape Architects, the Eco-tourism Society, National Parks and Conservation Association, National Oceanic, Greenpeace, and local community representatives. The results of the collaboration were published in a National Park Service Publication: "Guiding Principals of Sustainable Design" and a design for the new addition was developed. The new buildings were constructed with recycled materials, rainwater collection, solar power, heat mirror glazed windows and water and energy conserving appliances. An elevation drawing demonstrating how these products were used is shown as Figure 18 below.

[9] Resort Literature

Figure 18: Harmony Resorts Design Features



Source: J. Hadley Architect, Harmony Resorts, cited by Laura Zeiher, The Ecology of Architecture: 156.

The resort is now spread across two sites and includes a range of guest accommodations, including the original tents, more refined tents, studios, and small cottages.

Example 7: George Washington University[10]

Client Type: Institutional construction

Type of Work: New construction of a residence hall

Location: Washington, D.C.

Date of Completion: 1997

Cost of Construction: $15 million

In 1994, George Washington University formed a partnership with the Environmental Protection Agency to develop a model program for environmental management of its campuses and facilities. The partnership, referred to as the Green University Program, would develop procurement and

[10] Michael Fickes, "A Study in Green." School Planning and Management, No. 7, Vol. 36, July 1997: 26.

building guidelines, energy management systems, recycling programs, and academic programs on the campus. Construction and renovation of facilities are one of the most visible outcomes of the program. For example, energy management systems now control about 75 percent of the energy systems operating on campus - leading to energy efficiency of 15 to 20 percent. Similarly, green material selection and design specifications have been standardized for all future facilities projects. Overall, the program has sought to maintain a "cost-neutral position" while still moving toward a more environmentally sustainable construction program.

The largest project to date is a new nine-story, $15 million residence hall with 119 two-bedroom apartments. Exterior materials are conventional, yet durable, including granite, precast concrete trim, and brick facades. Similarly, the HVAC, lighting, and roofing systems are efficient, but do not exceed conventional specifications. Unusual features include a built-in refuse and recycling system, linoleum flooring made from recycled materials, and R-20 insulation (double the local code requirement) on the roof.

The university's construction department has developed a list of approved materials for future projects which include wood harvested from a managed forests, zero-formaldehyde emission particle board, recycled content non-CFC polystyrene insulation, recycled content doors and frames, 100 percent synthetic gypsum, 25 percent minimum recycled content for steel studs, recycled content acoustical panels, low-VOC paints, and energy-efficient kitchen appliances,

Section 4: Summary

Green building is applicable to a wide range of needs. Aspects can include leading-edge technologies or simple alterations to traditional methods and materials. These examples have provided only a brief sample of current green building initiatives. New buildings are developed each year with increasing frequency and attention. Further study of construction materials and techniques in other buildings in the U.S., Europe, Canada and Japan is encouraged for a better understanding of the possibilities in green building.

CHAPTER 5: INVESTMENT OPPORTUNITIES BY GREEN BUILDING ISSUE

Section 1: Overview

This section builds on the broad description of drivers, examples and trends laid out in Chapters 2 through 4 and uses the frameworks introduced in Chapter 1 to compare and contrast markets and products. As described earlier, there are four main issues within green building - energy conservation, indoor air quality, water conservation, and material conservation and reuse. The importance of each issue varies between the three top markets - residential, commercial, and institutional construction - and even within these markets. Sources will primarily rely on the broad range of interviews conducted with professionals in the building industry. Notes from all interviews and summaries of surveys are attached in Appendix F. Appendix G includes the summaries of conference visits and interviews by colleagues in Core Resources and Environmental Advantage Capital.

The first part of this chapter is structured by green building issue. It examines each issue separately - identifying current market perceptions, typical solutions, market needs, and emerging products and services. Each issue concludes with a ranking of its potential in the residential, commercial, and institutional markets, as well as an understanding of the connection between the concerns and capabilities of decision makers. Following a description of each issue, a section devoted to more holistic approaches to green building is presented.

As noted earlier, green building issues are not equally attractive as investment opportunities. Indoor air quality, for example, has the broadest appeal for the future, while energy conservation is fairly mature with limited growth opportunities. Material reuse is quickly developing in the residential sector, but is more limited in commercial and institutional because of the differences in materials and building practices. In contrast, water conservation receives relatively little attention - even in the arid Southwest states. These perceptions - and others - are detailed in the following chapter.

Section 2: Indoor Air Quality

A. Current market perception

Of the four main issues within green building, new products and services which improve indoor air quality (IAQ) have the most growth potential across the top market segments. Three main themes

differentiate it from the other environmental and health concerns, and make it particularly appropriate for investors who are interested in actively defining the market. First, this issue is most driven by the market and least by government regulations. Secondly, this issue is still new and developing, leaving a lot of room for growth in the three market segments. Finally, while some of the larger producers are actively involved with IAQ solutions, many successful smaller companies have developed and implemented innovative solutions to real problems. These three factors combine to make this issue attractive for the medium term investor.

Echoed in all surveys and interviews, indoor air quality is on the minds of developers, building owners, architects and engineers in the residential, commercial, and institutional markets. Following some of the well-publicized instances of sick buildings described in Chapter 3, the general public is more aware than ever of the health risks from indoor air pollution.

While building professionals are usually most concerned with reducing the risk of liability, some of the more progressive building owners are also interested in improving worker productivity. This interest develops from concern for their employees as well as good business sense: studies have demonstrated measurable improvements in worker productivity by increasing natural lighting and the exchange of fresh air in work spaces. Projects for several companies have eliminated toxic chemicals from finish materials and included individually controlled temperature zones to improve the working environment of its employees.

B. General approach to solving problems

Three approaches exist in improving indoor air quality: increasing ventilation, decreasing sources of indoor pollution, and installing air filters. While many options exist, the most common approach is to increase the exchange of fresh air in the building. The American Society of Heating, Refrigeration, and Air-conditioning Engineers (ASHRAE) standard today calls for an air exchange rate of .35 cubic feet per minute. Depending on the type of building and the needs of the occupants, this can be done simply by including additional, well-placed, operable windows in the building - as typically seen in schools and low-rise office buildings. For larger projects, like school gymnasiums and office towers, however, larger mechanical air handling units are necessary, because they are effective in all weather situations and require minimal changes in building design. Since building owners and developers are most concerned with the aesthetics of the building, this option allows the architect to design without concern for air circulation and then let the mechanical engineer adjust the loads to suit the exchange requirements in each space. Of course downsides to this segmented approach are the tradeoffs between energy efficiency and ventilation. For green building companies, this is also a source of opportunity - where inventors can develop improved ventilation equipment and building designs.

While most building owners might be satisfied with ASHRAE standards, certain industries - such as health care and pharmaceutical manufacturers - are driving additional innovations in ventilation. Food and Drug Administration regulations require high levels of fresh air in both situations to prevent mixing of chemicals and bacteria between spaces. Operating rooms in hospitals as well as pharmaceutical production require 100 percent air exchange - no air can be recirculated. These building changes are forcing designers and contractors to rethink how they do work in general; what is learned here may spill over into other less regulated areas. Instead of looking at the contamination of patients in the operating room, architects may focus on the contamination of children in schools or clerks in office buildings.

In addition to increasing the flow of fresh air, some designers and building owners have concentrated on reducing the presence of toxic chemicals in the building in the first place. The simplest method is to specify the same materials as usual, and then allow a period of time - be it a few hours or a few weeks - to allow the new materials to "off-gas" the majority of volatile organic compounds before reoccupying the newly finished space. After the installation of a new carpet, for example, the carpet trade group recommends ventilating a space with fresh air for 72 hours and waiting a minimum of 24 hours before moving occupants back into the building.

Since the exact nature of off-gassing is yet to be defined, the risks of multiple chemical exposure make removal of most chemicals a preferred approach to improving air quality. In order to promote both energy-efficiency and good indoor air quality, it is essential to select the least toxic building materials available. As discussed in Chapter 3, typical culprits are volatile organic compounds, especially formaldehyde, found in paints, carpets, adhesives, and office furniture.

Finally, where changes to the ventilation and building materials are impossible or too costly, filters offer a less elegant solution. Either in the form of a "super vacuum" which is used once a day or a continuous air filter, the technology rests on an electric or extra fine mechanical filter which removes all particles above 0.3 microns.

C. Evaluation of the Indoor Air Quality Issue by Market Segment

Residential Construction

Despite the need for healthy environments and the increasing rate of allergies in both children and adults, there remains a lack of consumer awareness on solutions to indoor air pollution. The result is an inefficient approach to improved IAQ by relying on filters and minor home improvement changes. Until home buyers are better able to convey their needs to builders, this trend is likely to continue. Like most features in residential construction, builders meet existing, apparent demand;

they do not to take risks on new trends. Though home builders are better equipped than the homeowner to improve indoor air quality, most will not risk using new, unproved designs or materials. In addition, real estate agents, the gatekeepers of information in residential construction, rarely discuss this issue. Disclosures of material hazards are limited to lead, asbestos, and radon at the most; they do not mention the presence or absence of VOCs, mold or poor temperature and humidity conditions. On the other hand, homeowners rarely research available options themselves, or state concrete needs to builders. Design changes for indoor air quality generally occur only with the most severe cases of chemical sensitivity.

Better information and packaging, however, could transform this industry. Because there are a range of solutions, elements of indoor air quality are accessible to the entire residential market. This combined with the personal incentives to create a home which is both comfortable and healthy gives IAQ good growth opportunities in this market. Surveys show that educated consumers place high importance on the health of their homes. The do-it-yourself market, for example, has demonstrated demand for no-VOC paint and other non-toxic alternatives for simple home maintenance projects.

One expectation for future change is the liability risk of builders whose houses have problems with indoor air quality. Given the possibility for litigation, some builders may resort to issuing disclaimers to their clients, including a list of materials used in the house along with possibly harmful contaminants.[1] If this were to happen, home buyers would become much more aware and interested in IAQ trade-offs. The builder, in the process, would educate the homeowner, provide alternative choices, and hopefully reduce his or her own liability.

Needs

While products are important in the end, the residential sector is most in need of information which is easily understandable and actionable. Ideally, this should be available from several sources - including real estate agents, home improvement stores and home design literature.

Once that hurdle is met, simple solutions that are easily installed by the homeowner are most important. On the assumption that the person affected most by the issue is more likely to act, the do-it-yourself market should be targeted more aggressively than it is currently. Pre-packaged solutions of coordinated finishes are recommended, where low-VOC paint, natural fiber rugs, and linens are combined to allow easy installation by the homeowner. Secondly, ventilation upgrades to new construction and existing systems are important. For the home builder, simple plans with improved

[1] Interview with Ed Lowans, Environmental Consultant, and Debra Wright, Canada Mortgage and Housing Corporation, Oct 30, 1997.

air circulation, natural ventilation, and pre-specified non-toxic materials would reduce the need for additional resources to address this issue independently.

Commercial Construction

In contrast to the residential market, building owners in the commercial and institutional sectors are aware and concerned about indoor air quality. This extends beyond the facility managers to the architect's design staff and contractors. One Boston-area contractor noted that at least 90 percent of his clients ask about this issue.[2] Concern for IAQ has been noted by progressive building owner-occupants such as the Gap, the Body Shop, Microsoft, and others. In addition, a series of office renovations in New York City (in addition to 4 Times Square) and other large metropolitan areas, have focused on a concept called "Smart Building for the 21st Century," where one of the major issues is the quality of indoor environments.

Commercial tenants, however, are less aware of IAQ - as news articles on the Motor Registry and other sick buildings become less frequent.[3] Nevertheless, the right marketing would spark renewed interest, especially if presented as a positive selling point for a new or newly-renovated building. Like residential construction, information to the tenants is a barrier. Even more important, however, are the motivations in building owners. As major commercial buildings are increasingly owned by REITs and other removed owners, renovation and construction decisions have become more short-term.[4] The main drivers to invest in IAQ are the risk of litigation and the competitive commercial markets where indoor environmental qualities set them apart. For this reason, high-end office renovation will be the most likely sector for growth. Service companies which are very salary intensive, like banking, law, and consulting, are the most likely customers.

Needs

The high-end office market, which is most ready for solutions for improved air quality, need new, healthier, products for interior retrofits. These products include partitions and office furniture, made from VOC-free materials, which incorporate plenums for localized ventilation and air quality control. Carpets with lower chemical emissions are also important. New development and manufacturing of these products is necessary, though some new products do exist in the European market. To increase availability locally, importing or licensing these products provides a good growth opportunity.

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[2] Interview with John Kennedy, Kennedy & Rossi, 11/4/97.
[3] Interview with Paul Melo, Coldwell Banker, 11/8/97.
[4] Interview with Jim Becker, Beacon Skanska, 11/14/97.

In the lower-end market, information and simple solutions for building tenants, architects, contractors and owners is just as important as in the residential market.

Institutional Construction

Institutional clients are particularly focused on indoor air quality. Unique among the three market segments, this is the only area where building owners consistently hire an industrial hygienist as a third-party consultant for the design team - and where architects defer to them on finish and ventilation decisions.

Institutional needs are similar to the traditional commercial office building, but go beyond that to include even more sensitive facilities such as hospitals, retirement communities, day care facilities, schools, university athletic facilities and dormitories. All of these are particularly dependent on good indoor environments. Also, the operators of these facilities seem to be particularly attune to the issues - more so than in the commercial sector. Similarly, professional facility managers - or at least a dedicated staff member - allow institutions to be more knowledgeable than the average homeowner.

While this market is more mature than the others, there remains a need for information - particularly in terms of product data and access. Smaller institutions without professional facility managers also need general information summarizing the issues and providing design guidance. Finally, there are few barriers to increasing the use of non-toxic, no-VOC products and improved ventilation in institutional buildings. Several low cost alternatives exist.

Summaries of these discussions on indoor air quality are shown below. As shown in Figure 19, indoor air quality is a high priority for all three markets with a wide range of high opportunity sub-markets.

Figure 19: Ranking of Indoor Air Quality by Market Segment

IAQ	Market Attractiveness	High Opportunity Sub-markets
Residential	Medium to High	• New construction of custom homes • New construction of speculative homes • Pre-packaged solutions for the DIY market
Commercial	High	• High-margin, high-salary companies - either tenants or building owners • Progressive firms which occupy their own buildings • Pharmaceutical companies already familiar with ventilation issues
Institutional	High	• Universities or others with long payback periods and willingness to test products • Private schools • Hospitals / HMO's

Figure 20 demonstrates that most decision makers in the three construction segments are both interested in IAQ and able to influence the design and construction process in some way.

Figure 20: Ranking of Decision-makers and Indoor Air Quality

Market	Decision Makers	Indoor Air Quality	
		Priority	Impact
Residential	Homeowner	**Hi**	Med
	Home builder	Med	**Hi**
	Architect	Med	**Hi**
	Remodeler	Med	Med
Commercial	Owner	**Hi**	Med
	Executive	**Hi**	Low
	Facility Mgr.	**Hi**	Med
	Tenant	**Hi**	Low
	GC	Med	Med
	Architect	Med	**Hi**
	Developer	Med	**Hi**
Institutional	Trustee / Board	**Hi**	Med
	Facility Manager	**Hi**	**Hi**
	Architect	Med	**Hi**
	GC	Med	Med

D. Investment Opportunities with Potential for Growth

Emerging products / systems / services

In summary, the IAQ market provides great opportunities for investment - at many levels. Needs are fairly similar across markets, although the scale and details of the product may differ. New products on the market fall into four categories - substitute building materials, ventilation systems, filters, and services.

For all markets, investment in No-VOC paints, adhesives, carpets, particleboard, filters, and monitors are important.

- Paint: The production of no-VOC paints is a strong growth market, but primarily dominated by the large paint companies. Market entry to this $13 billion industry is limited through consolidation as well as patenting, making most of the investment opportunities accessible only to market leaders. Even there, total market growth is limited because the no-VOC alternatives will only displace existing products. The expiration of patents and increased competition between the major producers have already lowered no-VOC paints to the same price point as other quality paints. No-VOC paint development may be more a strategy of maintaining market share rather than developing additional market growth. Favorite products of green builders are Glidden Spred 2000 and Benjamin Moore Pristine Paints.
- Carpet: There is currently no affordable, VOC-free carpet. Advances have been made in minimizing the chemicals in carpet backing and adhesives, but natural materials remain the only non-toxic alternative for the carpet top, and generally cost 2 to 6 times the synthetic variety. Because of this, long-term investment opportunities exist in developing and patenting a healthy alternative to traditional nylon carpet. This market is somewhat consolidated, but several small companies have demonstrated the ability to differentiate themselves through technical innovation and new product development. Collins & Aikman, the inventor and producer of completely recycled carpeting for the commercial market, is one of these companies. Interface Carpets is also actively pursuing more environmentally sound alternatives to traditional carpet production methods. Development may bring carpet out of its current market slump.
- Adhesives: Adhesives, caulks and sealers are a $1.5 billion retail market and a top culprit in chemical off-gassing both during and after construction. The industry is fragmented, leaving room for individual firms with innovative solutions to consolidate the industry and grow. Again, because green product prices are only 1 to 1.5 times the price of traditional products, there are good growth opportunities here. A favorite producer among green building experts is American Fabricating and Manufacturing (AFM), from San Diego, CA. Some of the traditional producers, such as DAP and Franklin have also recently produced lines of VOC-free products but are not nearly as broad and well-regarded as AFM.

- Air Quality Sensors: In high-end residential, office construction, and some institutional facilities there is a sizable opportunity for integrated products that can control space humidity, temperature, and fresh air levels independently of one another. Research on combined systems that use desiccants to control humidity and vapor compression air conditioning to control temperature is expected to result in an efficient, integrated system that can provide better comfort at reduced operating costs.
- Air Filters: Air cleaners are a $150 million retail market, with increasing growth as building occupants look for simple ways to improve air quality without the expenses and time delays of renovation or new construction.

For the residential market, there are additional opportunities in both products and services:

- Residential Ventilation Systems: As described earlier, there is a conflict between energy efficient HVAC systems and indoor air quality. Therefore, good ventilation systems which provide a high air exchange rate but do not decrease the tightness of the building are in demand. Air-to-air heat exchangers are the favorite product at the moment. Again, this sector is fairly fragmented with room for consolidation as well as growth in better quality products. Notable companies include Vent-Aire Systems, Nutech, and Honeywell. Products vary in price and features. Some replace residential furnaces and water heaters and cost 2-3 times as much as traditional systems. Others are efficient additions to an existing forced air system and cost less than a standard heat exchanger and fan coil.
- Home Improvement Solutions: Pre-packaged solutions with healthier alternatives to the typical DIY project are necessary because of the lack of information or brand recognition in indoor environment products. Jointly marketed products for specific projects around the house could solve this problem by combining all of the relevant healthy paints, floor coverings, furniture, and decorations into one easy-to-recognize package. For example, all parents are concerned with the health of a newborn child and most renovate a room in the house when a new baby is brought home. A suggested solution is a line of products which are jointly marketed, use the most healthy materials available, and are geared to the nursery. This could be followed then with a line of "Healthy Home" products for the entire market. Half-hearted versions of this marketing have been made by companies ranging from L.L. Bean to an environmentally-geared linen catalog. However, no one has created a full line of products which are available in a major store, such as Home Depot or Sears.
- Healthy Homes: A few steps beyond the natural nursery idea, opportunities exist for homes which are designed and constructed with a holistic approach to improving indoor air quality. This is not a new idea and there are several examples of existing projects which were built for chemically sensitive clients and as model homes for the American Lung Association. Nevertheless, these projects were custom designed and built and have not been available on a

large scale for the average home buyer. Similarly, home builders are looking for ways to differentiate themselves. The development of a series of well-designed, traditional-looking homes which use the most healthy products available at similar price points would allow a builder to distinguish their properties from others on the market. Also, if a larger builder could adopt some of these plans and move down the learning curve quickly through volume, it could develop streamlined ordering of some of the more unusual products - possibly even developing exclusive sourcing which would create barriers to entry for copying builders.

For the commercial and institutional office markets, three products are needed:

- Raised flooring systems: Instead of installing dropped ceilings to conceal wire conduits and HVAC plenums, a system of raised flooring panels have been used in Europe and Latin America for several years. Recently imported to the U.S. market, these products improve upon the dropped ceiling in several ways. First, they utilize nine inches of space versus twelve to twenty-four for the average ceiling system, allowing shorter distances between floors in new construction and providing full access to tall windows in renovations of older buildings. Secondly, the floor level plenums are not only more energy efficient than their predecessors but also connect to plenums in coordinated desks and partitions to provide heated or cooled air directly to the individual's upper body. If accepted by the building market, growth opportunities are large and could include a significant portion of the office renovation market.

- Office furniture and partitions: Despite the growing concern over office air quality, few manufacturers of office systems focus on the chemical make-up of their partitions, desks, and chairs. As discussed, many of these are comprised of particleboard and foams which off-gas formaldehyde and other VOCs. A large producer of office systems, Hermann Miller, has developed systems made from recycled materials, but it currently has no lines which are free of VOCs. However, a much smaller company, Lowenstein, specializes in VOC-free products, which sell at the same price point as high quality commercial furniture.

- Energy efficient commercial ventilation: Like the problem in the residential sector, commercial contractors and designers noted a need for innovation in heat exchangers and HVAC units, in general. One contractor noted that, for years, mechanical systems have lagged far behind structural systems in their innovations. Green Building initiates could well be the impetus for change in this industry.

Section 3: Energy Efficiency

A. Market Perception

Energy efficiency is often the most visible aspect of green building. It is recognized by all markets, though not always pursued beyond building code requirements. For most, energy costs are currently too inexpensive to warrant significant design changes or equipment upgrades. As noted by one contractor, "energy efficiency is addressed by 90% of customers, but acted on by only 10%."[5] In fact, some clients apply for waivers to meet lower efficiency standards than required by code. In general, investments in energy efficiency are most relevant for large scale, low margin operations and in new technologies which offer only long term payback periods.

Current approach to solving problems

As one of the oldest concerns of the green building movement, energy efficiency is also one of the most mature. Most decisions on energy efficiency are driven by building codes which dictate minimum R-values for insulation in walls, roofs, and windows, as well as rating requirements for efficiencies of appliances, water heaters, and lights. For those clients who desire additional energy efficiency, most choose double pane windows, thicker wall and roof insulation, more efficient appliances, and more efficient lighting. In addition, good design including passive solar elements and natural ventilation help reduce heating and cooling bills. A solution which receives much attention from the climate change scientists, but little from the building community, is installing light colored roofing instead of typical dark shingles. This one change in roof color is estimated to save roughly 40 percent in avoided cooling costs across the country. Even in temperate climates this would be effective. Also important in the effort to curb emissions of carbon dioxide is a trend toward substituting natural gas for electricity, which many consumers do for comfort and convenience, as well as cost savings. Less common additional steps are alternative energy systems - including photovoltaics, wind and geothermal energy.

B. Evaluation by Market Segment

Residential Construction

In residential construction, energy efficiency is consistently rated as one of the top green issues by both home buyers and home builders. Nevertheless, there is little interest beyond meeting building codes and installing energy efficient appliances. In renovations of older homes, wall and roof insulation, as well as double pane windows will be specified, but generally will not exceed the

[5] Interview with John Kennedy, Kennedy & Rossi, 11/4/97.

standards of new construction. Given increasing discount rates at the margin, the homeowner is often less willing to spend another $100 or $1000 dollars on energy efficiency, even though lower operating costs will create a short payback period. Surprisingly, among the most environmentally-focused builders, energy efficiency is less of a priority than healthy interiors and resource conservation.

Market Needs

In residential construction, the appropriate building products are available to create very energy efficient homes. One significant unmet need is for improved efficiency in mechanical equipment - such as HVAC systems and hot water heaters. Other market needs include information, marketing, and design and construction skills.

While all homeowners would prefer lower utility costs, the majority do not make this factor a major consideration when buying a new home. As noted in the NAHB's 1996 survey of homeowners, energy efficient appliances were the only energy related desire on the top ten concerns in buying a home. To increase the concern beyond this issue - the homeowner needs additional information and incentives from trusted sources. Real estate agents are the most likely source of this information, along with their Multiple Listing Service - a database of details on homes for sale. Making this information public, however, may be difficult without legislation or significant state or local pressure. Real estate agents, generally, do not want to add any information voluntarily that may discourage home sales.

As usual, when the demand is fuzzy, the supply of energy efficient houses will be weak. The majority of builders will not spend the limited resources they have designing and marketing energy efficient houses. While there are creative (and risk-taking) builders who develop energy efficient houses and then guarantee energy costs below a certain level, there numbers are low. The majority of builders are not willing to add more long term risks to an already long list of warranties.

Awareness and interest could increase, however, if changes are made in the information flow about utility costs, if Green Builder Programs develop around the country to recognize these energy efficient homes, and if banks reward energy efficiency with lower interest rates or higher mortgage limits. On the supply side, builders need better designs that incorporate passive solar and passive ventilation elements into houses, while keeping with traditional building styles. Secondly, marketing plans for builders to tout the benefits of energy efficient houses are important.

Commercial Construction

In commercial construction, building owners and tenants are typically much more inquisitive about utility costs, partly due to the scale of the costs and partly due to professional facility managers, whose jobs revolve around such data. The sale of an existing office building, for example, includes a package of information on the operations of a building, including all of the monthly rental income and monthly utilities and maintenance costs. Again, due to the scale, this information is much more detailed than what is provided in residential construction. In addition, the recent focus on Building for the 21st Century includes smart systems and designs which reduce energy consumption, as well as providing more comfortable environments.

Energy conservation is limited, however, for building tenants who have little input in the construction of a building. The struggle between the building owner's plans for low construction costs and the tenants desire for low operating costs is usually won by the owner. While tenants may be able to replace existing lighting with more energy efficient models, the most energy consuming features of a building - the mechanical systems and insulation qualities - have already been installed before their arrival.

Those companies which are most likely to make investments in energy efficient systems are likely to be owner-occupied buildings for either very progressive companies who are investing in an image or low margin operations where utility costs are a relatively high portion of their total costs. The first example might be a leading high-technology or consumer products company. The latter may be a hotel or apartment building.

For building owners, there are few barriers to implementing energy efficient technologies, if the paybacks are less than two or three years at the time of an already planned construction or retrofit. Information on new energy saving products, however, is difficult to track. Sweet's, the ubiquitous catalog of building products, contains manufacturers' literature but there is no objective source of comparative information for the commercial sector.

Institutional Construction

Institutional construction is fairly similar to commercial construction in the information and guiding incentives. In some ways, institutions may be more ready to make investments in energy efficiency because they are often willing to accept longer payback periods. In addition, most are building owner-occupants and less subject to the mismatch of incentives found with the building owner and tenant.

On the other hand, budgets are often limited, meaning that simple solutions - efficient lights and bolstered insulation - are generally the target of design changes. Like commercial construction, improved mechanical equipment is the focus of desired improvement. As shown in Figure 21, energy efficiency is a low to medium growth issue within the top market segments. As in commercial construction, growth opportunities exist in two disparate groups: image conscious owner-occupants with long payback periods and low-margin operations with high energy consumption.

Figure 21: Ranking of Energy Efficiency by Market Segment

Energy Efficiency	Market Attractiveness	High Opportunity Sub-markets
Residential	Low-Med	• Affordable housing, custom homes
Commercial	Med	• Owner-occupied with low margins, hotels • Progressive owners, design for the 21st century
Institutional	Med	• Universities or others with long paybacks, willingness to test products • Low-margin, high energy consumers - hospitals, dormitories

Figure 22 identifies the priorities and impacts of key decision makers and shows that there is little connection between those who value energy efficiency and those who make the building decisions.

Figure 22: Ranking of Decision-makers and Energy Efficiency:

Market	Decision Makers	Energy Efficiency	
		Priority	Impact
Residential	Homeowner	Med	Med
	Home builder	Med	**Hi**
	Architect	Med	**Hi**
	Remodeler	Low	Med
Commercial	Owner		
	Executive	Low	Low
	Facility Mgr.	Med	Med
	Tenant	Med	Low
	GC	Low	Med
	Architect	Low	**Hi**
	Developer	Low	**Hi**
Institutional	Trustee / Board	Med	Med
	Facility Manager	Med	Med
	Architect	Low	**Hi**
	GC	Low	Med

C. Emerging Products and Services: Investment Opportunities

Despite this lukewarm appreciation for energy efficiency, several products are interesting as they work well to solve other challenges in construction.

- Wall Panels: Primarily for the residential market, a variety of different wall panels provide an energy efficient alternative to traditional 2'x4' construction with plywood sheathing and fiberglass batt insulation. These wall panels come in many forms, but generally include higher R-values than standard construction, thicker walls, and integrated exterior and interior finishes. In many cases, these panels are also structural. Example producers are EnerGrid, FasWall, Agriboard, Homasote Co., and Tenneco. Panels by some of these producers are also material conserving by using recycled raw materials, such as packaging material, agricultural waste, and newsprint. EnerGrid, for example has negligible raw material costs, as it uses waste Styrofoam collected at no cost from shippers and distributors of products which come surrounded by protective foam.

- When built efficiently, most wall panels cost the same or less than a completed 2x 6 framed wall with insulation. Traditional construction practices, however, present a significant barrier to the use of these panels. Because they replace on-site dimensional lumber construction, all trades would have to revise their typical work sequence - creating scheduling and estimating conflicts. These hurdles could be overcome through factory built modular construction, providing good market growth and potential industry consolidation.

- Alternatives to Fiberglass Insulation: Several new types of insulation are on the market which offer alternatives to fiberglass insulation. Cellulose insulation, for example, is made from recycled paper and cotton waste and is often selected for clients who are allergic to fiberglass. This industry has recently undergone consolidation by Greenstone Industries and Louisiana-Pacific. Another group of alternative insulation includes specialized foam products installed by licensed contractors. One popular example is Icynene, which is made from modified urethane and does not off-gas. It has been used in Canada since 1982.

- Hot Water Heating: Several new products have been developed which both save energy and increase comfort and convenience in the home. Water recirculating devices and tankless water heaters provide hot water on demand. This eliminates the wait for hot water which is so common in most homes. They also avoid tank and line energy losses and cost less to install and operate than the traditional boiler. In the process, they reduce the waste of potable water, an additional economic and environmental benefit. Many small manufacturers are active in this market,

including Advanced Tech Industries, American Water Heater, Controlled Energy Corp., and Rheem/Ruud.

- Grid-connected, building-integrated photovoltaics: Photovoltaic (PV) technology is one of the most promising and efficient forms of solar technology, because it directly converts the sun's light into electricity. With billions of dollars in investment, however, PV systems have been slow to develop commercially. Nevertheless, hope remains that lower production costs, higher efficiency, better designs, and utility net-metering combined will produce a stronger market in the traditional construction sector. Arthur D. Little has projected that the annual U.S. market for PV on buildings could top $2.5 billion in the next ten years.[6] Solar tiles have been developed in Japan and in the United States a new PV shingle is commercially available. More recent advances have included PV panels as spandrel materials for commercial construction, as demonstrated at 4 Times Square. International growth is expected to be even higher (averaging 15 to 20% annually).

  Grid-connected, building-integrated panels provide two benefits over traditional roof-mounted PV modules. First, real-time metering of energy consumption and peak load sell-back programs will provide cost savings only available to grid-connected PV systems. Secondly, new PV panels and shingles replace traditional roofing material, thus making the building more attractive and reducing the incremental additional cost of the panel. In addition, federal and state tax credits along with utility grant and lending programs are expected to help subsidize initial investments under programs such as the Million Roofs Campaign and similar state programs.

- Geothermal Energy: Geothermal heat pumps draw naturally heated water from 150 to 250 foot wells and supply space heating and cooling in over 100,000 buildings in the United State.[7] Most of these sites exist in California and the western Mountain states where geothermal temperatures are known to be warmest and most cost effective for heating. The potential for geothermal energy is large, but the expense (over $12,000 for a residential system) and environmental consequences of tapping some of the more remote reserves create barriers to wide spread use. However, in the right location, it is one of the cheapest sources of energy, second only to hydroelectric power. The industry is growing 10% to 20% annually in North America.

- Transpired Collectors: Geared primarily toward the industrial market, a transpired collector is an exterior wall panel which collects solar energy in an air space between the exterior and interior wall and recirculates this air through the facility with a fan. The wall can also be used to cool the

[6] "An Architects Guide to Photovoltaics", American Institute of Architects Research, 1997.
[7] Zeiher, 74.

space, by venting the warmed air to the outside instead. One example is the patented Solar Wall, which replaces a typical exterior metal wall. Payback periods for the initial investment run from three to six years, depending on whether the system is retrofitted or included in the original building design. This product has been in use since the early 1990s in industrial facilities for General Motors, Federal Express, and others.

Section 4: Material Conservation and Reuse

A. Market Perception

Like indoor air quality, material conservation and reuse is an emerging issue in green building. Unlike indoor air quality, though, most mainstream architects, contractors, and building owners do not consider material conservation when designing a new building. Even though designers may not go out or their way to find material conserving products, they are probably already using them for their durability and stable costs. For example, recent changes in residential construction have increased the use of products which conserve wood. Many of these changes in material specifications have been driven by deteriorating lumber stocks. As the trunk sizes of harvested trees shrink, lumber producers have been forced to develop new ways to build longer spans with smaller pieces of wood. In the end, a wide range of engineered wood products developed which achieve longer spans and have more stable prices than their dimensional lumber equivalents. Similarly, many recycled-content materials are more durable and less expensive than their traditional counterparts.

Combining low cost and high quality is the most sustainable way to attract customers to green building, leaving environmental qualities as an added benefit. For this reason, several material conservation products have great potential in the coming years - particularly in the residential segment where lumber shortages and high construction site waste are growing problems.

B. Evaluation by Market Segment

Residential Construction

Residential construction is the most applicable market for recycled material and material conserving products, primarily due to rising costs of construction waste disposal to both the builder and the community. Similarly, the depletion of old growth forests for logging means that lumber is less plentiful and less stable in price than it was previously. Recycled material content products are also becoming popular for exterior finishes because they are more durable and require less maintenance than their predecessors. Surprisingly, these environmental qualities are rarely advertised.

Beyond these basic products, material conservation is recognized by only a niche group of builders. While the issue may not be on the minds of individual home builders, the reduction of construction waste is a very important issue for the home building industry, in general. In fact, Kitsap County's Green Builder program was started by focusing only on this issue. Limitations to their local landfill concerned the leaders of the local home builders association (HBA), because the next landfill in the area was across a range of mountains and tipping fees were nearly three times the current rates. The HBA set up the Green Builder Program at first to mandate construction site recycling and the program grew to encompass other green issues. The landfill problem is difficult to solve, because it requires a number of independent contractors to devote their resources to the good of the community. Recycling construction waste requires the coordination of many parties and low margins may not warrant the effort without government intervention. Nevertheless, the Kitsap program currently provides only a carrot - recognition and marketing as a Green Builder. In the future, though, failure to comply may also include a stick.

Market Needs

To unleash the potential of recycled material use in the construction industry, a systematic approach to waste recovery, reuse, and resale is needed in a community. This has yet to occur on a large scale and will probably require a combination of marketing innovation to increase demand for the recycled products as well as regulatory policy to create a stable supply of recycled raw materials. Nevertheless, small success stories from different communities have indicated that a closed loop recycling and reuse system is possible. In Kitsap county, a mandate to recycle waste gypsum board encouraged the opening of a recycled gypsum plant - further fueling the use of recycled materials in the community.[8]

Again, information on products is needed by designers and home builders who wish to specify recycled materials, but have difficulty comparing products or finding local distributors.

Commercial and Institutional Construction

In commercial and institutional construction, little concern is given to material conservation or recycled products. Similarly, the market for these products is much smaller than in the residential market. Engineered lumber, as well as exterior sidings and decking products made from recycled waste materials, have only a niche market in commercial and institutional projects. The most likely materials for growth are interior finishes, such as sustainably harvested lumber or lumber substitutes such as bamboo for use in flooring and other finishes. Alternatives to plywood and drywall, such as

[8] Interview with Art Kastle, Kitsap Co. Washington HBA, 11/14/97.

recycled material boards are also relevant for interior partitions, particularly where the products are non-toxic and hence improve indoor air quality.

On the supply side, while residential builders face significant costs from waste disposal, commercial and institutional construction is not proportionally as wasteful. Structural steel and steel studs - major elements of commercial and residential construction - are ordered with less waste and what little waste exists is already separated out for recycling, because of the relatively high resale values. The result makes steel the most recycled material in the United States.

Figure 23 summarizes the divergence in market perceptions on material reuse and conservation.

Figure 23: Ranking of Material Conservation and Reuse by Market Segment

Material Reuse and Conservation	**Market Attractiveness**	**High Opportunity Sub-markets**
Residential	Medium to High	• All home builders • Environmental niche custom homes • Local recycling, waste group
Commercial	Low to Medium	• Progressive owner-occupants
Institutional	Low	• Progressive owner-occupants

Within the residential sector, the home builder is the most influential decision-maker, as shown in Figure 24.

Figure 24: Decision Making and Material Reuse and Conservation

Market	Decision Maker	Material Reuse	
		Priority	Impact
Residential	Homeowner	Low	Low
	Home builder	**Hi**	**Hi**
	Architect	Low	**Hi**
	Remodeler	Med	Med
Commercial	Owner	Low	Low
	Executive	Low	Low
	Facility Mgr.	Low	Low
	Tenant	Low	Low
	GC	Med	Med
	Architect	Low	**Hi**
	Developer	Low	Med
Institutional	Trustee / Board	Low	Low
	Facility Manager	Low	Med
	Architect	Low	**Hi**
	GC	Med	Med

C. Emerging Products: Investment Opportunities

New products in this growing market include the following investment opportunities:

- Sustainably harvested lumber: Currently a small portion of the total lumber market, sustainably harvested lumber is sold at the same price point as equivalent products from traditional lumberyards. Because of this free "environmental bonus," once consumers are aware of the availability of sustainably harvest lumber, they may specify it over alternative products. One barrier to market growth is limited local availability. Growing certification of public forests should increase supplies, however. While the current certification process requires initial investments of up to $100,000 for large land owners and annual inspection fees, opportunities to increase market share may make the investment worthwhile.

- Recycled Carpet: Several companies have developed carpeting made from elements of old recycled carpet, though only Collins & Aikman has developed a nylon carpet from 100% recycled carpet - called ER2. In a great example of economies of scope, Collins & Aikman has introduced a unique system, where the carpet delivery truck delivers and installs a client's new carpet, removes the old carpet and pad and transports them back to the main factory for shredding and reprocessing into a completely new carpet. In the end, no solid waste is produced, raw material and disposal costs are nominal, and transportation costs are unchanged. The ER2 carpet was introduced in 1997 and has exclusive standing orders from Blockbuster and the Gap for store renovations. Products are currently limited to the commercial and institutional markets, however.

- Recycled material panels: Like the wall panels discussed in the section on energy efficiency, these panels are substitutes for traditional gypsum wallboard and interior grade plywood. Products are made from recycled gypsum, newsprint and agricultural waste and sell at similar prices to traditional drywall. Agriboard and Strammit are well regarded producers. Recovered wood medium density fiberboard (MDF) is a growing market. CanFibre of Toronto is building a $120 million plant in California to manufacture recycled wood MDF. Ponderosa Products is another large producer, with $20 million in revenues.[9]

- Recycled material exterior siding: Siding made from recycled wood, cellulose, fiber and cement are extremely popular for their durability and workability. Popular examples include HardiPlank, a lap siding product made from cement, ground sand, and cellulose fiber, which requires little maintenance, resists warping, is waterproof, noncombustible, and carries a 50-year warranty. In addition, it can be nailed, painted, and stained like normal wood siding. Other products by the HardiPlank manufacturer can be used as siding, fascias, soffits, and skins for laminated panels. Similar products are made by Georgia-Pacific, Louisiana Pacific, and Smurfit Newsprint Corp.

- Plastic Lumber: Plastic lumber is usually a recycled material made from a combination of post consumer thermoplastic and recycled wood fiber. The result is a range of products for decking, railings, fences, and garden furniture which require no maintenance and can be easily molded into custom shapes. Trex is a popular product for decking which costs 20 percent less expensive than quality redwood and is much more durable. Another producer, Earth Care, has recently acquired several small plastic lumber producers in an attempt to consolidate the industry and develop more vertical integration.

- Recycled-material tiles and countertops: Tiles and countertops are manufactured from a wide variety of raw materials, including recycled ceramic tiles, by-products of feldspar mining, recycled auto and aerospace glass and curbside glass. The products also range in price from the same price as economy lines of ceramic tile to 7 times this. Appearances, colors, and sizes are similarly varied. The producers are extremely small and often serve only regional distributors.

- Engineered Lumber While initially oriented toward commercial and institutional buildings, engineered lumber is now growing rapidly in the residential market. In an attempt to displace a portion of the sizable dimensional lumber market, this product provides longer spans, easier workability, and more consistent prices. Engineered lumber benefits the environment by requiring one third the wood as an equivalent dimensional member. Market leaders are Trus Joist MacMillan and Louisiana-Pacific.

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[9] Jerry Powell, *Resource Recycling*, November 1997: 33 as reprinted by GreenClips, December 1997.

Section 5: Water Conservation

A. Market Perception

Water conservation is the most mature aspect of green building, with the least room for market growth. A minor issue in even the most arid states, it is completely dwarfed by the issues of energy efficiency, indoor air quality and material conservation in other areas. Like energy conservation, the most relevant markets are low-margin, high-water consumers - hotels, hospitals, and large housing complexes with centrally metered water. As described in Chapter 2, in certain older urban areas, like Boston - water rates are increasing rapidly and receiving significant attention from residential and commercial markets alike. Whether this will result in increased water conservation or just more political debate, is uncertain.

Current approach to solving problems

Even more so than energy efficiency, water conservation is driven by building codes. Designers and contractors work to meet the requirements of codes which specify low-flow toilets, faucets and showers. Beyond this point, only niche builders are active. Similarly, there is little research in new product development in this field.

B. Evaluation by Market Segment

Residential

If new products were available, they would be received with little enthusiasm because water rates are typically so low. In fact, the trend toward enormous bathrooms with proportional bathtubs points away from water conservation.

One notable exception to this rule, however, is the multifamily housing market - and particularly low income housing developments where water meters are centralized and paid by a central operations group, not by individual tenants. The Boston Housing Authority, for example, is particularly interested in water conservation and promotes builders of water conserving buildings.[10]

An issue which is important in all sectors of the residential market is water quality. This is normally addressed by filter companies, such as Culligan Water, and other large competitors in residential tap-filters and water delivery.

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[10] Interview with Steve Stuntz, GreenVillage Homes, 12/10/97.

While the conservation of potable water is often limited, there remains marginal interest in two alternatives to wastewater treatment: gray water systems and alternative septic systems. Both face resistance from health inspectors, though they are suitable for specific markets. The first, gray water systems, provide a parallel network of plumbing to return slightly contaminated water for reuse in fixtures which do not require potable water (like toilets and landscape spigots). While initially more expensive, because of the materials and labor required to build the system, if designed and completed at the outset, the savings in conserved potable water can payback the cost of installation in two to three years.

The second option, alternative septic systems, is most relevant in rural settings which are not connected to the local sewer system and which have the land to develop the small wetland needed to decompose the wastes before discharging them into another septic system.

Commercial and Institutional Construction

Like residential construction, little attention is paid to water conservation by the commercial and institutional construction sectors. Exceptions to this rule include hotels (hence the "reuse a towel" campaigns), hospitals, multifamily housing, and dormitories. Though not included in this discussion, the industrial sector - particularly the pharmaceuticals and semiconductor markets - are especially interested in water consumption and purity because their usage and quality demands are so high.

As summarized in Figures 25 and 26, water conservation is generally unattractive to most markets. Exceptions include low margin, high usage operations in each market.

Figure 25: Ranking of Water Conservation and Market Segments

Water Conservation	**Market Attractiveness**	**High Opportunity Sub-markets**
Residential	Low	• Large low-income housing developments
Commercial	Low	• Large, owner-occupied, low margin operations: Hotels
Institutional	Low	• Hospitals, University dormitories

Figure 26: Decision Making and Water Conservation

Market	Decision Makers	Water Conservation	
		Priority	Impact
Residential	Homeowner	Low	Low
	Home builder	Low	**Hi**
	Architect	Low	**Hi**
	Remodeler	Low	Med
Commercial	Owner	Low	Low
	Executive	Low	Low
	Facility Mgr.	Low	Low
	Tenant	Low	Low
	GC	Low	Med
	Architect	Low	**Hi**
	Developer	Low	Med
Institutional	Trustee / Board	Low	Low
	Facility Manager	Med	Med
	Architect	Low	**Hi**
	GC	Low	Med

C. Emerging Solutions - Investment Opportunities

In water conservation, few opportunities are available for new product development. For the few building owners that are interested in water conservation, simple renovations and the installation of low-flow fixtures are sufficient. Innovations in gray water systems and wetland systems are environmentally sound but growth is limited. The appropriate markets are small, barriers from health inspectors are significant, and initial costs are high. These products will attract only niche markets, including progressive commercial and institutional clients and rural, residential markets in arid regions.

Section 6: Summary of Opportunities in the Green Building Issues

In summary, investment opportunities are best directed at products which satisfy the following characteristics:

- Easy entry and growth: unstructured industries with room for consolidation
- Aligned incentives: market segments where key decision makers' priority and impact are both high or medium.
- Market-ready products: where low cost, quality, and appearance are already aligned with market needs.

- Multiple Solutions: products which solve more than one problem for the consumer.
- Focus on comfort over philosophy.

Finally, market perceptions of the four green building issues could best be summarized in the following table (Figure 27) which shows that indoor air quality is the strongest market followed by material conservation and energy efficiency. The most approachable construction segment is the institutional market, though residential and commercial are by no means weak.

Figure 27: Overall Market Perceptions

	Indoor Air Quality	Energy Efficiency	Material Conservation/ Reuse	Water Conservation
Residential	Hi	Med	Med-Hi	Low
Commercial	Hi	Med	Med	Low
Institutional	Hi	Med	Med	Med

Section 7: Whole System Services

While each of the above issues has merit in different markets, the most interesting investment opportunities are in products and services which cut across issues and solve primary barriers to green building. The new opportunities here represent ideas which solve the main problems of information, marketing, and construction services addressed in the opening of this thesis. Some of these opportunities are up and running, others are developed but yet unfunded, and others are merely ideas. Options include catalogues, a manufactured housing plant, a design center, a building rating program, a green builder marketing service for home builders, and a construction waste recycling program. Some are geared to the residential market, some to commercial or institutional, and some to both.

A. Information

The need for additional information has been a repeated theme in discussions with building professionals from all construction segments. Until recently, most of the information for green building techniques was distributed by word of mouth, informal databases, and internet web pages. This sporadic information did not suit the needs of all possible parties. The truly green builder needed more detailed information on recent product developments and local availability; the novice

required information on designing and building with green products; and the uninterested professional needed motivation and incentives to incorporate green building elements. All of these needs are now being addressed by relatively recent services.

- Professional journals: For the building professional, two dedicated sources of information offer new product descriptions, design solutions, regulatory review, and other articles on green building throughout the United States. The most established and well-respected source is a bi-weekly newsletter called *Environmental Business News (EBN)*, published in Vermont. This newsletter was established in 1992 and has since developed a subscriber base of 2000. A new journal, called *Environmental Design and Construction* published its first issue in October 1997 to meet the green building needs of the architecture, engineering and construction (AEC) community.
- Product catalogs - For the practitioner who needs detailed information on specific products as well as sourcing data, at least ten local and national directories are available providing a range of information quality and quantity. Prices range from negligible to $200. The Harris Directory, by B.J. Harris, is one of the original databases, and is available for free, by sending a blank disk to the author. Other versions are published by local Green Builder programs and universities. A recent national version was published in early 1997 and is available for $40. It is called the *Green Building Resource Guide* and includes a very helpful set of symbols and price indices. Finally, the first installment of a "Green Sweets" was published in December 1997. This catalog was developed with EBN and is called *What's Working Green Products Catalog.* It includes a green building introduction to each building product category, product reviews and ratings, and manufacturers literature. The authors plan to make this the national standard for Green Building information, and will follow up the original catalog with a CD-ROM and possibly searchable internet-based databases.
- Green Building Design Center: Under construction and scheduled to open in February 1998, the Design Center for EcoSmart Healthy Properties will be located on the entire 23rd floor of Trump Tower in New York City. This prominent address will provide physical displays of up to 500 green building products - from furniture to flooring. The center will be open to the public and tour groups of architects, students, developers, contractors, and bankers will be encouraged to attend. The center operates by charging manufacturers a flat rental fee for display space - producing $1 million in revenue. The revenue is then partly used to run the center and partly used to host large commercial and residential developers for profession presentations on the economic and environmental benefits of green products. This idea presents one of the first truly mainstream approaches to increasing public awareness to green building products.
- Rating Services - Rating programs - like *Consumer Reports* or the nutrition labels on food packaging - provide objective, comparable information to the consumer. These standards increase credibility of individual products as well as the industry as a whole. Green Seal and SCS certify the environmental claims of green products, in general, and serve several large building

material producers. The U.S. Green Building Council has developed standards for rating the environmental and health qualities of entire buildings, using inspiration from similar programs in Canada and Britain. Their program - called LEEDS - is still in development, but will soon inspect buildings for a fee and provide a plaque outside the building with relevant details on the building's environmental qualities.

- Internet Services: Today's green building movement is strongly fueled by the internet. Countless web pages providing information on environmental and health issues in buildings have been published by government agencies, university programs, non-profit organizations, private companies, and individuals. A guide to green building internet sources is included in Appendix H. One particularly informative option is a free biweekly email service from GreenClips which collects and reproduces articles relating to green buildings.
- Computer Building and Environmental Design Programs: While there are a number of computer aided design (CAD) programs on the market, none incorporate all of the relevant environmental and health information in one package. As discussed earlier, there are often trade-offs in designing and constructing green facilities. Architects and builders have no simple and effective way to measure these trade-offs and then explain them to their clients. This type of program would be a good step in helping the current green builders. It would also lower the information barriers for new entrants.
- Green Building Real Estate Services With the expected growth in both supply and demand for green buildings, a gatekeeper will soon be needed to share information and bring parties together. Demand exists today for the small market of chemically-sensitive home buyers, but this should grow with great consumer awareness. The market for traditional real estate agent services generates $10 billion in commissions and is heavily weighted toward residential clients.

B. Marketing

While information sources are developing quickly, savvy marketing programs are less strong. EcoSmart Healthy Properties is probably the most sophisticated marketer in the industry and they are just starting out. The size and nature of the construction and building materials industries require a more targeted approach for green building for this to grow into a mass market. Ideas include marketing services for home builders and small building product manufacturers - organizations that traditionally do little marketing.

- Marketing Services for Home builders: This service would provide simple designs, product specifications, and advertising literature for home builders wishing to introduce green homes. Interviews with builders and HBA representatives in areas with new Green Builder programs indicated that the small staffs at most home builders are overwhelmed by the design options and product variety in building green. In addition, they have a difficult time explaining the benefits

of their homes to the public and differentiating their product from others. As Green Builder programs expand, similar challenges for builders will develop in other cities. Marketing services could grow with Green Builder programs, spreading knowledge from one market to another.

- Consolidated Marketing for Small Producers: Small manufacturers have a difficult time growing beyond a regional distribution model, because their marketing skills are often limited and unprofessional. Small staffs often do not understand the larger market and do not know how to explain their benefits to unfamiliar customers. Along the same lines, several green builders and architects want information on specialty producers, but can not find it. Several producers do not even have web pages, a good starting point in this web-savvy industry. Consolidated marketing would combine the resources of several producers - within the same product category or not - and develop professional quality market research and advertising programs. They could also bundle their products into simple categories for purchase by novice homeowners or home builders. This service would help the industry grow beyond its current boundaries and provide even greater growth opportunities to members of the consolidated group.

C. Developers / Builders

While several green builders exist, few operate on a national scale or have practical plans for national growth. Two developers, however, have a model which can be replicated.

- GreenVillage: GreenVillage manufactured homes is a prefabricated modular home producer based in Cambridge, MA. While only a business plan, this idea builds on the experience of two local prefabricated builders and adds several green elements to the design. What makes this so attractive is that not only does GreenVillage take advantage of trends pointing toward an increased acceptance and use of premanufactured homes and components, but it also solves several barriers to green building. For example, a housing factory has consistent employment - making training feasible and relatively inexpensive and resolving important issue in installing alternative green building products. Secondly, the factory also provides closed conditions and a high level of quality control conducive to high tech building components. Finally, the factory can be replicated to similar markets, growing with the spread of Green Builder programs.
- Commercial Green Developers: Durst Organization and EcoSmart Healthy Properties have positioned themselves as top developers in high-end green office construction and renovation. The market in key cities is significant and gives these companies a differentiating factor compared to their traditional counterparts. Expansion into large institutional work is recommended.

Section 8: Summary

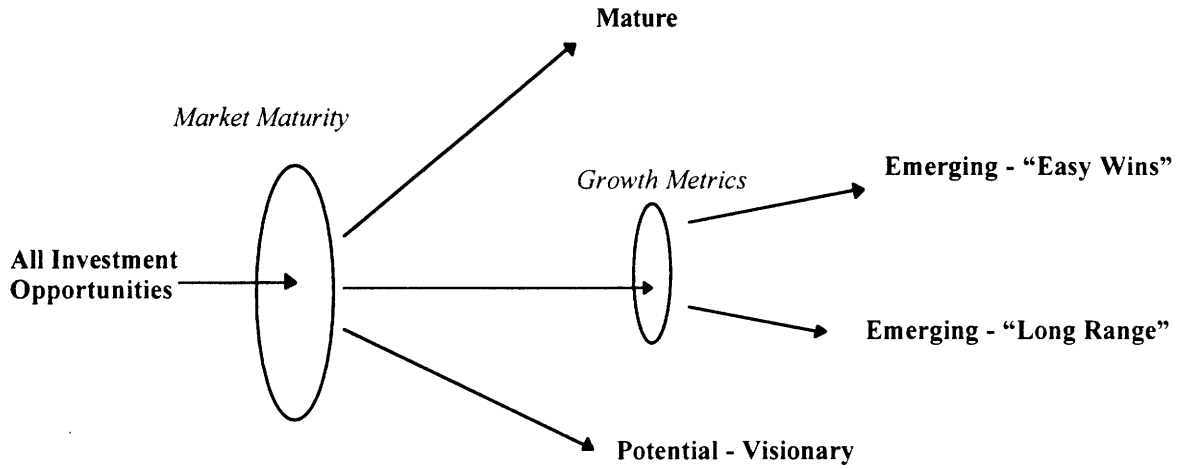
Both products and services will be important investment opportunities as building green develops beyond initial niche markets. In addition to the qualities of successful new products identified in Section 6 of this chapter, successful services will improve consumer awareness, develop product and industry credibility, and communicate information to a wide range of building professionals. Needs for information and marketing are strong across all markets, but particularly important in the residential sector.

CHAPTER 6: PRIORITIZING INVESTMENT OPPORTUNITIES

Section 1: Review of Screening Tools

As described in the introduction to this paper, the wide range of investment ideas presented in Chapter 5 is sorted and targeted toward specific types of investors. Two sets of screens are used to identify which products and services are the best opportunities for shorter and longer term prospects. Figure 28 is repeated as a refresher.

Figure 28: Screens for Investment Opportunities



Where available, market information - including industry structure, barriers to entry, technology development - was presented in the description of each product or service. This data is used first to screen investment ideas by the maturity of the market, using the screens shown in Figure 29.

Figure 29: Overall Ranking of Investment Opportunities

Mature Opportunities	Emerging Opportunities	Potential Opportunities
• Few additional technology changes in current industry.	• New technology developments expected, but fairly well understood.	• New technology development expected, but still in R&D
• Consolidated industry with high barriers to entry.	• Fragmented industry, possibly in the process of consolidating.	• Totally fragmented industry
• Not a major focus for outside investors.	• Room for market entry	• Room for market entry
	• Commercial market development within five years	• Commercial market development beyond five years
		• No market leadership
		• Current market barriers to growth - cost, code, technologies

Section 2: Results of the Market Maturity Screen

While the division is not exact, a rough segmentation is provided using the results from Chapter 5. This screening produces three segments - mature, emerging, and potential market opportunities.

A. Mature Investment Opportunities:

As discussed in earlier sections, a few green issues face fairly mature markets. Early regulations for energy efficiency have motivated product development for years - to the point of diminishing returns on some products. Similarly, water conservation has been directly regulated for a decade with specific product requirements focusing and limiting innovation.

Nevertheless, continued investment by the market leaders is still relevant. As large companies compete against each other, these limited opportunities can be incorporated into larger marketing programs - providing opportunities for differentiation. Likewise, the importance of energy efficiency to the nation and the environment has not diminished; the continuation of environmental problems leaves open the possibility for increasing energy prices or water rates. Mature opportunities are summarized by green issue or service in Figure 30.

Figure 30: Mature Investment Opportunities

Energy Conservation	• Low-E Windows • Mineral Insulation • Energy Efficient Appliances • Energy Efficient Lighting
Water Conservation	• Low Flow Toilets • Low Flow Showerheads and Faucets
Indoor Air Quality	• Operable Windows • Standard HVAC systems • No-VOC Paint • Air Filters
Material Conservation	• Renovation of existing buildings • Recycled furniture • Recycled paint • Reused copper and steel building components
Services	• Architectural Design Services • Custom Green Builders • Environmental / Health Consultants • Green Building Newsletter • Architect-oriented books on Green Building • Environmental specialty distributors • Internet Services • Rating Programs

B. Emerging Opportunities

Emerging opportunities (Figure 31) are the most numerous and practical for most investors. They include niche products such as transpired collectors as well as the potentially large markets for GreenVillage premanufactured homes. Because of this breadth, emerging opportunities will be further segmented in Section 3.

Figure 31: Emerging Investment Opportunities

Energy Conservation	• Wall Systems / Panels • Cellulose and Foam Insulation • Hot Water Heating Technologies • Transpired Collectors
Water Conservation	NA
Indoor Air Quality	• No-VOC Adhesives • Air Quality Sensors • Improved Residential Ventilation Systems • Home Improvement Solutions • HealthyHomes • Raised Flooring Systems • Office Furniture and Partitions • Improved Commercial Ventilation
Material Conservation	• Sustainably harvested lumber • Engineered lumber • Composite Siding • Recycled material composite siding • Recycled carpet • Recycled material interior panels • Plastic Lumber
Services	• "Green Sweets" • Marketing Program for Home Builders • Green Distribution through traditional home centers • Consolidated Marketing for Small Producers • GreenVillage • Commercial Green Development • Computer building design and environmental assessment programs • Green Realtor

C. Potential Opportunities

Potential opportunities (shown in Figure 32) are long term investments. Because of the market-oriented focus of this thesis, the list is shorter than exists in the labs of today's universities and larger companies. The products mentioned here are commercially available and have been used in many of the example projects of Chapter 4. Because of higher initial costs, however, true mass appeal is more than five years off. If new technology advances lower costs, greater potential for growth exists.

In the mean time, potential opportunities may be better investments for individuals and organizations with very long horizons and a dedication to the issue.

Figure 32: Potential Investment Opportunities

Energy Conservation	• Grid-connected, building-integrated photovoltaics • Geothermal energy • Wind energy
Water Conservation	• Gray water systems • Alternative septic systems
Indoor Air Quality	NA
Material Reuse	• Closed loop recycling programs

Section 3: Screening the Emerging Opportunities

A. Defining the metrics:

The large category of emerging technologies will be further segmented by comparing aspects of potential market size, market entry, and barriers to growth. The category "easy wins" will characterize the products or services that are expected to provide relatively high returns for the investment risk. "Longer range" investments may also be sizable, but face larger barriers to growth. Following are definitions for these metrics:

> **Target Market:** This will identify the target market for the product or service. Specific sub-segments will be noted, where applicable.

Replacement or New: This metric will note whether the idea replaces an existing building product or service or is an addition to existing components. Due to the slow pace of change and small margins in the construction industry, replacement products are expected to be more well received than new products. While these replacements will have to displace market share of existing products, this should not be too difficult in a fragmented market - as long as quality and price are in line or better than traditional products. New products will have to focus primarily on higher margin, niche customer groups.

Equivalent Traditional Product: This identifies the most common equivalent traditional product that would be substituted by the new green product.

Potential Market Size: This provides a rough approximation for the market size of a new product, by assuming a ten percent market penetration into the market share of the traditional product. For example, if engineered lumber is estimated to reach a ten percent share of the $24 billion dimensional lumber market, this would produce a potential market size of $2.4 billion. Where no equivalent product exists, alternative calculations for potential market share will be noted.

Price Premium: Compares the price of the new product to that of an equivalent traditional product. Where the new product ranges from 0.8. to 1.2 times the price of the traditional, this will be considered roughly equivalent in price and will be noted with a darkened circle: ● Where the new item is priced 1.2 to 2 times the traditional product, this will be considered high: ○; and where they are over 2 times the traditional price, this will be very high ○. While these metrics will vary between individual products, this gives an estimate of the average premium.

Opportunities for Outside Investors: This metric notes the ease of entry into a market segment and includes all options from starting a new firm to acquiring a small start-up or investing partially in a medium-sized firm. Good opportunities will be noted with a darkened circle, while lower opportunities with a light circle.

Fit with Current Construction Practices: This notes how well the existing product works into the traditional construction system. If the product can be installed exactly the same way as the traditional product, without impacting the schedule or access of other trades, this is considered highly compatible. Again, good fit will be noted with a darkened circle and poor fit with a light circle.

Barriers to Growth: Additional barriers are noted when strong competitors, technology

development, building codes, and other market hurdles are expected to hinder new product entry and growth.

B. Energy Efficiency

Emerging opportunities in energy efficiency are shown in Figure 33.

Figure 33: Market analysis for Energy Conservation

Metrics	Wall Systems / Panels	Cellulose and Foam Insulation	Hot Water Heating Technologies	Transpired Collectors
Market Served	New Residential Construction	All markets	All Markets	Industrial Buildings and Gymnasiums
Replacement of New	Replacement	Replacement	Both	New
Equivalent Traditional Product	2 x 4 construction	Fiberglass Batt Insulation	Boilers	No equivalent, except standard metal wall
Potential Market Size (10 % of traditional)	$ 4 bil.	$200 million	$100 million	small
Price Premium	○	●	○	○
Opportunities for Outside Investors	●	○	●	●
Fit with Current Construction Practices	○	●	○	○
Barriers to Growth	• Transportation • Coordination with trades	• Special equipment and licenses limits use by homeowners • Formidable competitors		• Wall systems are not integrated with existing pre-engineered metal building system

In this category, only new hot water heating technologies are considered a top investment priority. The savings in operating costs are only a portion of the benefit. In addition, shorter waits for hot water and quicker replenishment make water recirculating and other hot water heating technologies strong products for convenience and comfort. All other products are considered longer term, mostly because energy efficiency is a hard market to enter and these products, while desirable, have high

barriers for the outside investor. Several factors would have to change to make these "Easy Wins". For one, energy prices would need to rise. Secondly, typical construction practices would have to accommodate the new products.

C. Indoor Air Quality

Market analysis for products and services that improve indoor air quality are shown in Figures 34 and 35.

Figure 34: Market Analysis for Indoor Air Quality - Part I

Metrics	**No-VOC Adhesives**	**Air Quality Monitors**	**Improved Residential Ventilation Systems**	**Home Improvement Solutions**
Target market	All markets	All markets	Residential	Residential
Replacement or New	Replacement	Both	Replacement	Replacement
Equivalent Traditional Product	Regular Adhesives	Traditional thermostats	Fans, HVAC	Paint, Carpet, Linens, Fans
Potential Market Size (10 % of traditional)	$150 million	$250 million	approx. $1 billion	approx. $100 million
Price Premium	●	○	○	●
Opportunities for Outside Investors	●	○	○	●
Fit with Current Construction Practices	●	●	○	●
Barriers to Growth	----	• Technology Development • Major Competitors: GE, Honeywell, Johnson Controls	• Technology Development • Strong Competitors	• Packaging • Potential competition from other retailers

Figure 35: Market Analysis for Indoor Air Quality - Part II

Metrics	HealthyHomes	Raised Flooring Systems	Office Furniture and Partitions	Improved Commercial Ventilation
Target Market	Residential new construction	Office, Hospitals - New and Major renovations	Offices	Offices, Schools, Hospitals,
Replacement or New	Replacement	New	Replacement	Replacement
Equivalent Traditional Product	Traditional Homes	Substitutes for dropped ceiling and HVAC ducting	Furniture	Traditional HVAC
Potential Market Size	$20 billion	$20 million	$800 million	approx. $1 billion
Price Premium	●	●	●	○
Opportunities for Outside Investors	○	●	○	○
Fit with Current Construction Practices	○	○	●	○
Barriers to Growth	• Strong competition in homebuilding	-----	-----	• Technology • Strong Competitors

As already noted, indoor air quality is a top market with several high potential products. These include no-VOC adhesives, raised flooring systems and office furniture. HealthyHomes can be incorporated with the GreenVillage option and will be considered a strong opportunity. Air quality monitors and improved ventilation systems are longer term opportunities, due to expected price premiums, strong competitors, and technology development requirements.

D. Material Conservation and Reuse

Market analysis of investment opportunities in material conservation and reuse are summarized in Figures 36 and 37.

Figure 36: Market Analysis for Material Conservation - Part I

Metrics	**Sustainably Harvested Lumber**	**Recycled Carpet**	**Recycled Material Interior Panels**	**Plastic Lumber**
Market Served	Residential, Office	Residential, Commercial, Institutional	Residential, Commercial, Institutional	Residential
Replacement or New	Replacement	Replacement	Replacement	Replacement
Equivalent Traditional Product	Traditional Lumber	Traditional Carpet	Gypsum Drywall	Exterior Grade Lumber
Potential Market Size (10 % of traditional)	$2.4 billion	$500 million	$250 million	$200 million
Price Premium	●	●	●	●
Opportunities for Outside Investors	●	○	●	○
Fit with Current Construction Practices	●	●	●	●
Barriers to Growth	• Limited supply of managed forests	• Patented technology	------	-------

Figure 37: Market Analysis for Material Conservation - Part II

Metrics	Engineered Lumber	Composite Siding
Market Served	Residential	Residential
Replacement or New	Replacement	Replacement
Equivalent Traditional Product	Traditional Lumber	Traditional wood or vinyl siding
Potential Market Size (10% of traditional)	$2.4 billion	$150 million
Price Premium	●	●
Opportunities for Outside Investors	○	●
Fit with Current Construction Practices	●	●
Barriers to Growth	• Large companies already dominate market	-----

Material conservation and reuse is such a new issue that there remain several good, yet untapped, product and service opportunities. All ideas have good growth opportunities, but some are more accessible to the outside investor than others. Recycled material interior panels, plastic lumber, and recycled material composite siding are the best choices. The limited supply and good growth potential makes sustainably harvested lumber also a good option. Recycled carpet and engineered lumber are more difficult to enter because of technology barriers and strong competition.

E. Green Building Services

Market opportunities for the wide range of green building services is shown in Figures 38 and 39. Because many of these services have no equivalent in traditional construction, approximate market sizes are shown based on target customers, housing starts or other metrics.

Figure 38: Market Analysis for Services - Part I

Metrics	"Green Sweets"	Marketing Program for Homebuilders	Consolidated Marketing for Small Producers	Green Realtor
Target Market	All markets	Residential	All markets	Residential
Replacement or New	Both	New	New	Replacement
Equivalent Traditional Product	Sweets Catalog			Traditional real estate agent
Potential Market Size	$2 million[1]	$2 million[2]	$20 million[3]	$1 billion
Price Premium	●	●	●	●
Opportunities for Outside Investors	●	●	●	●
Fit with Current Construction Practices	●	●	●	●
Barriers to Growth	• Will always be only a supplement to Sweet's • Publishing of similar, lower priced products by non-profits	• Cost barriers to low-margin builders	--------	--------

[1] 10% of all building professionals * $70 per book.
[2] 10% of housing starts by the top 8 non-prefab homebuilders * $200 / house.
[3] 1% of all building material industry * 1% of revenues = 200 billion (.01) * (.01)

Figure 39: Market analysis for Services - Part II

Metrics	Distribution Through Traditional Home Centers	Computer Design Program	Commercial Green Building Development	Green Village
Target Market	Residential	All markets	Commercial and Institutional	Residential
Replacement of New	New	Replacement	Replacement	Replacement
Equivalent Traditional Product	--------	Traditional CAD	Traditional development	Traditional Homes
Potential Market Size (10 % of traditional)	$14 billion[4]	$10 million	$ 8 billion	$ 20 billion
Price Premium	●	◍	●	●
Opportunities for Outside Investors	○	●	○	●
Fit with Current Construction Practices	●	●	●	●
Barriers to Growth	• Competition from existing home centers	--------	• Difficult to enter	• Competitive Homebuilding industry

A high demand for services in the green building market makes many of these ideas good investment opportunities. Most of the easiest options, however, have small estimated markets - including the Green Sweets, the computer program, and the marketing programs for homebuilders and small producers. Distribution through traditional home centers is a good channel development opportunity for existing market leader, but more difficult for outside investors. Similarly, commercial green building development is most accessible for current large general contractors. Green Village and Green Realtor, finally, are accessible opportunities with large potential markets.

Section 5: Summary

In the end, the two screens produce a continuous range of product and service opportunities which will suit a broad spectrum of investors. The best options for the outside investor with a relatively short investment horizon are shown in Figure 40.

[4] 10% of retail building product revenues.

Figure 40: Emerging Easy Wins

Energy Efficiency	• Hot Water Heating
Indoor Air Quality	• No-VOC Adhesives • Raised Flooring Systems • Office Furniture and Partitions
Material Conservation	• Sustainably Harvested Lumber • Recycled Material Composite Siding • Plastic Lumber
Services	• Green Sweets • Marketing Program for homebuilders • Marketing Program for small producers • Computer Design Program • GreenVillage • Green Realtor

CHAPTER 7: CONCLUSION

Section 1: Summary of Findings

In summary, this thesis has demonstrated that building green is important for the future - of the environment, the construction industry, and the larger community. Moreover, green building is a sustainable trend with elements that are not only attractive, but accessible, to many parties.

As an investment focus, opportunities exist in the latent demand for green building products and services, especially in the U.S. markets of residential, owner occupied commercial, and institutional construction. While complicated decision making, inadequate information and inefficient distribution currently limit the size and profitability of this market, several possibilities exist for growth. Within this context, this thesis has focused on identifying the importance of this issue for the environment, highlighting major drivers in the market, and screening high growth investment opportunities

Green building has been segmented into four main concerns - energy efficiency, water conservation, material reuse and conservation, and indoor air quality. Market perceptions and practices indicate that indoor air quality shows the best growth potential for investments. Energy efficiency and material reuse are strong in particular markets, while water conservation receives little attention. Finally, products and services which address a number of these issues in a more holistic manner are very strong investment opportunities - with a wide range of potential market sizes.

Section 2: Recommendations for Further Research

As stated in the introduction, this thesis was intended as an initial business analysis of the growing green building market. Opportunities for further research are broad and include needs for additional detail on specific products or markets as well as research on overcoming larger industry barriers.

Research on the products and services introduced in this thesis could yield more detailed market analysis, specific business plans or additional design innovation. For example, additional research on the development of Green Builder programs for the residential market could provide marketing insight for the NAHB, local Home Building Associations, and individual home builders. More specifically, the marketing of coordinated Healthy Home products for the do-it-yourself market could be the topic of a business plan for those interested in consumer products and the presentation

of green building to the mass market. Additional work is needed in designing prototypes for green buildings in all construction sectors as well as in developing improved ventilation systems, computer analysis tools, and renewable energy technologies. Finally, research on construction segments excluded from this study - such as the federal building market or public schools - could yield important market data on niche opportunities.

Ideas in the development and marketing of new green building products may still be hindered by barriers to change in the larger construction industry. Because of this, continued research on the impacts of industry structure, financing, and public policy is encouraged. For example, the growing market share of large builders, the consolidation of home centers, and the increasing use of premanufactured components will largely impact the incorporation of green building products in residential construction. Likewise, attempts to foster multi-disciplinary design teams will greatly influence the construction of "smart buildings" and supporting integrated building systems.

The combination of long building lives and significant investment needs limits the willingness of building owners and contractors to experiment with new technologies. While new systems may reduce operations costs over time, decision makers generally concentrate on the significant initial investment. To avoid high discount rates at the margin and encourage smart long term investments, new approaches to financial structures should be explored. This may involve longer contracts, performance guarantees, or leasing arrangements. Finally, continued examination of public policy would be meaningful in assessing subsidies, tax abatements, loan guarantees, and other incentives for green building.

In conclusion, green building faces both great opportunity and significant barriers in the future. While certain markets and products appear to be most relevant in the near term, more detailed research is needed to develop and prioritize marketing strategies and technological innovation.

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Appendix A: Building Material Market Size Calculations:

Standard Construction Division	SIC Code	Discription	Value of Shipments ($ bil), 1994	Value of Shipments ($ bil), 1998 predicted	Total Establishments , 1998 predicted	Total Employment, 1998 predicted (000)	Percent of output to buildings / construction	Total shipments to construction ($ bil)	Total for Division $ billion
Division 1 General									
Division 2 Sitework									
	3084	Plastics Pipe	3.6	3.4	288	14.7	80	2.72	2.7
Division 3 Concrete									
	3271	Concrete Block & Brick	2.4	2.7	905	18.2	98	2.646	
	3272	Concrete Products	6.8	8	3011	67.8	90	7.2	
	3273	Ready-Mixed Concrete	13.8	15.4	5017	88.9	98	15.092	
	3241	Hydraulic Cement	4.8	4.6	200	12.5	33	1.518	
									26.5
Division 4 Masonry									
	3251	Brick & Structural Clay Tile	1.3	1.4	226	14.4	98	1.372	
									1.4
Division 5 Metals									
	3315	Steel Wiredrawing & Steel Nails	5	5.8	383	28.1	90	5.22	
	3316	Cold Finishing of Steel Shapes	6.5	7.9	214	16.6	75	5.925	
	3317	Steel Pipes & Tubes	6.3	6.8	248	23	80	5.44	
	3321	Gray Iron Foundries	9.7	9.4	551	69.1	15	1.41	
	3324	Steel Investment Foundries	1.5	2	150	20.7	15	0.3	
	3351	Copper Rolling Drawing & Extruding	7.3	8.5	101	18.2	5	0.425	
	3357	Drawing & Insulating Nonferrous Wire	15.4	16.9	563	58.6	45	7.605	
	3441	Fabricated Structural Metal	9.8	9.9	2412	59.6	60	5.94	
	3444	Sheet Metal Work	6.5	7.2	4900	120	70	5.04	
	3446	Architectural Metal Work	1.2	1.4	1380	27	95	1.33	
	3448	Prefabricated Metal Buildings	3.9	3.9	514	24	80	3.12	
	3449	Misc. Metal Work	1.4	1.5	730	22	95	1.425	
									43.2
Division 6 Wood and Plastics									
	2421	Sawmills and Planing Mills	27	29	5203	143.8	34	9.86	
	2426	Hardwood Dimension & Flooring Mills	2.8	3	776	34.4	18	0.54	
	2429	Specialty Product Sawmills	0.1	0.2	139	1.7	80	0.16	
	2435	Hardwood Veneer and Plywood	2.6	2.9	312	21.8	42	1.218	
	2436	Softwood Veneer and Plywood	6.6	6.9	170	28.9	42	2.898	
	2439	Structural Wood Members	4	4	994	33.8	99	3.96	
	2491	Wood Preserving	3.5	3.9	485	12.3	90	3.51	
	2493	Reconstituted Wood Products	5.4	6.2	340	24.3	10	0.62	
	3069	Fabricated Rubber	7.7	9	1231	59.3	4	0.36	
	3082	Unsupported Plastics Profile Shapes	3.8	4.5	747	27.6	10	0.45	
	3083	Laminated Plastics Plate & Sheet	2.4	2.3	354	13.8	10	0.23	23.8
Division 7 Thermal and Moisture Protection									
	3086	Plastics Foam Products	11	12.9	1390	72	13	1.677	
	3296	Mineral Wool	3.7	3.8	253	19	70	2.66	
									4.3
Division 8 Doors and Windows									
	2431 (partial)	Millwork*	11.6	13.6	3554	106.3	100	13.6	
	3442	Metal Doors, Sash & Trim	7.9	8.6	1202	67.4	95	8.17	21.8
Division 9 Finishes									
	3086	Plastics Foam Products	11	12.9	1390	72	8	1.032	

	2851	Paints Varnishes Lacquers Enamels	17.3	19.2	1400	49.6	52	9.984	
	3253	Ceramic Wall & Floor Tile	0.8	1	138	9.8	95	0.95	
	3275	Gypsum Products	2.8	2.8	174	11.5	85	2.38	
	3281	Cut Stone & Stone Products	1.1	1.3	900	14.3	50	0.65	
	3429	Hardware	10.5	10.9	1280	74.8	26	2.834	
	3431	Enameled Iron & Metal Sanitary Ware	0.9	1	92	6.7	99	0.99	
	3432	Plumbing Fittings & Brass Goods	3.2	3.8	177	19.2	85	3.23	
	3996	Hard Surface Floor Coverings	1.7	2	30	7	40	0.8	
	2273	Carpets & Rugs	11	12	380	58	25	3	
									25.9
Division 10 Specialties									
	2434	Wood Kitchen Cabinets	3.1	3.7	4897	75.2	100	3.7	
									3.7
Division 11 Equipment									
	3264	Porcelein Electrical Supplies	1.1	1.1	146	9.5	100	1.1	
	3443	Fabricated Plate, Boiler Shops	10	10.3	1700	70	25	2.575	
	3491	Industrial Valves	4.6	5.5	583	54	40	2.2	
	3492	Fluid Power Valves & Hose Fittings	4.3	4.7	372	29	40	1.88	
	3534	Elevators & Moving Stairways	1	1	184	6	90	0.9	
	3526	Hoists, Cranes, & Monorails	1	1.3	170	8	40	0.52	
	3639	Household Appliances	4	4.7	57	13	50	2.35	
									11.5
Division 12 Furnishings									
Division 13 Special Construction								154.291	
Division 15 Mechanical									
	3431	Enameled Iron & Metal Sanitary Ware	0.9	1	92	7	90	0.9	
	3088	Plastics Plumbing Fixtures	1.4	1.6	486	15.7	100	1.6	
	3261	Vitreous Plumbing Fixtures	1	1.2	65	9.5	100	1.2	
	3433	Heating Equipment, Except Electric	2.7	2.6	117	14.6	60	1.56	
	3494	Valves & Pipe Fittings, NEC	2	1.9	127	10	40	0.76	
	3498	Fabricated Pipe & Fittings	3	2.7	784	21	40	1.08	
	3564	Blowers & Fans	3.5	3.7	600	25	20	0.74	
	3585	Refrigeration & Heating Equipment	24	26	956	127	30	7.8	
	3634	Electric Housewares & Fans	3	3	164		10	0.3	
	3822	Environmental Controls	3	3.2	330	23	60	1.92	
									17.9
Division 16 Electrical									
	3613	Switchgear & Switchboard Apparatus	6	6.5	575	34	40	2.6	
	3641	Electric Lamp Bulbs & Tubes**	3	2.8	90	12	5	0.14	
	3643	Current Carrying Wiring Devices	4.9	5.7	491	40	55	3.135	
	3644	Noncurrent-Carrying Wiring Devices	3.7	4	200	22	55	2.2	
	3645	Residential Lighting Fixtures***	1.8	1.8	432	14	45	0.81	
	3646	Commercial LIghting Fixtures	3.5	4	345	23	45	1.8	
	3699	Electric Equipment & Supplies	5	5	490	25	20	1	
									11.7
Division Services									
TOTAL									**194.3**

* Windows 28%, Doors 32%, Trim 40%
** 40% personal consumption
*** 16% personal consumption

Appendix B: National Association of Home Builders 1996 Survey Results

Includes the Environmental Survey of Consumers and the Builder Survey of Environmental Issues 1996 - both sponsored by the NAHB Economics Department

Environmental Issues Survey of Consumers

(Based on 645 respondents)

Economics Department
National Association of Home Builders
Washington, D.C. 20005

ENVIRONMENTAL ISSUES SURVEY OF CONSUMERS

1. When you bought your last home did **environmental issues** influence your purchase decision? **(X ONE Box)**

   1 ☐ Greatly 2 ☐ Somewhat 3 ☐ Not at all 4 ☐ Not applicable

2. If you buy a home in the future, how much will environmental issues influence your purchase decision? **(X ONE Box)**

   1 ☐ Greatly 2 ☐ Somewhat 3 ☐ Not at all

3. How often do you do each of the following? **(X ONE Box For EACH)**

	Never	Once In A While	Sometimes	Always
Take public transportation to work	1 ☐	2 ☐	3 ☐	4 ☐
Share ride/car pool to work	1 ☐	2 ☐	3 ☐	4 ☐
Drive to work alone	1 ☐	2 ☐	3 ☐	4 ☐
Recycle waste	1 ☐	2 ☐	3 ☐	4 ☐
Conserve home energy use	1 ☐	2 ☐	3 ☐	4 ☐
Conserve water	1 ☐	2 ☐	3 ☐	4 ☐
Patronize companies with good environmental records	1 ☐	2 ☐	3 ☐	4 ☐
Use environmentally friendly products	1 ☐	2 ☐	3 ☐	4 ☐
Volunteer or work for environmental group	1 ☐	2 ☐	3 ☐	4 ☐
Other (Specify): _____	1 ☐	2 ☐	3 ☐	4 ☐

4a. Did you check the **environmental record** of the builder before you bought your last home?

   1 ☐ Yes 2 ☐ No

4b. Would you check the **environmental record** of a builder before buying your next home?

   1 ☐ Yes - (Continue) 2 ☐ No - **(Skip To Qu. 5)**

4c. What methods would you use to check the environmental record of a builder? (X ALL That Apply)

1 ☐ Environmental organization
2 ☐ Friends
3 ☐ Newspaper/journals
4 ☐ Market research
5 ☐ Marketing materials supplied by the builder
6 ☐ Local Home Builders Association
☐ Other (Specify): _____

5. Consider the following hypothetical choice. Your income is high enough to purchase a $150,000 home. You have two options: buying a $150,000 townhouse in an urban setting close to public transportation, work and shopping. Or, you could purchase a larger, single-family home in an outlying area, with longer commutes to work but with more open space. "X" the home you would like to buy.

1 ☐ $150,000 townhouse in the city
2 ☐ $150,000 single-family home in outlying suburban area

6a. If you were buying a home, would you purchase a home guide explaining environmental products and building technologies? (X ONE Box)

1 ☐ Yes → (Continue)
2 ☐ No
3 ☐ Not sure → (Skip To Qu. 7)

6b. How much would you be willing to pay? (X ONE Box)

1 ☐ Less than $15
2 ☐ $15 to $25
3 ☐ More than $25

7. Please rate the importance of the following issues, features and products/amenities when you buy a new home in a community, using a scale where "1" means "not at all important" and "5" means "very important". (X ONE Box For EACH)

	Not At All Important				Very Important	Not Sure
Energy efficiency of home	1	2	3	4	5	6
Indoor air quality	1	2	3	4	5	6
Price	1	2	3	4	5	6
Design and layout of house	1	2	3	4	5	6
Location	1	2	3	4	5	6
Preservation of existing trees	1	2	3	4	5	6
Preservation of existing wetlands	1	2	3	4	5	6
Adequacy of roads	1	2	3	4	5	6
Preservation of animal species and plant species which are endangered	1	2	3	4	5	6
New landscaping	1	2	3	4	5	6
Open space	1	2	3	4	5	6
Proximity to public transportation	1	2	3	4	5	6
Jogging and walking paths/trails	1	2	3	4	5	6
Lake	1	2	3	4	5	6
School district	1	2	3	4	5	6
Proximity to shopping	1	2	3	4	5	6
Recreational facilities	1	2	3	4	5	6
Safety	1	2	3	4	5	6
Other (Specify): _____	1	2	3	4	5	6

8a. Please rate the importance of the following products and amenities when you buy a new home in a community. (X ONE Box For EACH)

	Not At All Important				Very Important	Not Sure
Building products manufactured specifically for chemically sensitive individuals, i.e., respiratory/allergy problems	1	2	3	4	5	6
Solar heating	1	2	3	4	5	6
Built-in recycling containers	1	2	3	4	5	6
Steel framing	1	2	3	4	5	6
Wood framing	1	2	3	4	5	6
Increased energy efficient appliances	1	2	3	4	5	6
Water conserving plumbing	1	2	3	4	5	6
Radon resistant construction techniques	1	2	3	4	5	6
Water conserving landscaping	1	2	3	4	5	6
Water filtering system	1	2	3	4	5	6
Other (Specify): _____	1	2	3	4	5	6

8b. Please indicate how willing you are to pay for each of the following products and amenities when you buy a new home in a community. (X ONE Box For EACH)

	Not At All Willing				Very Willing	Not Sure
Building products manufactured specifically for chemically sensitive individuals, i.e., respiratory/allergy problems	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐
Solar heating	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐
Built-in recycling containers	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐
Steel framing	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐
Wood framing	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐
Increased energy efficient appliances	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐
Water conserving plumbing	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐
Radon resistant construction techniques	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐
Water conserving landscaping	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐
Water filtering system	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐
Other (Specify): _____	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐

9. Should the government offer tax incentives to private landowners when they restore/protect endangered wildlife habitat on their property? (X ONE Box)

1 ☐ Worth doing 2 ☐ Not worth doing 3 ☐ Not sure

10. Please rate your approval or disapproval for the following statements using a scale of 1-5 where "1" means "strongly disapprove" and "5" means "strongly approve". (X ONE Box For EACH)

	Strongly Disapprove				Strongly Approve
Government money should be spent to save all endangered species whether cave bugs or bald eagles	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Government money should be spent to save all endangered species even in cases where scientific evidence indicates it is not possible to do so	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Builders/developers (eventually home buyers) should be required by government to pay for preservation of endangered species whether cave bugs or bald eagles	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Builders/developers (eventually home buyers) should be required by government to pay for preservation of endangered species even in cases where scientific evidence indicates it is not possible to do so	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Government should not be able to take away private property without compensation	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Government should limit use of private property if an endangered species is found on it	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Costs to save species should be shared equally by government and landowners	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐

11. How would you rate the importance of protecting jobs and economic opportunities, protecting property values, and protecting the environment, using a scale of 1 to 5? (X ONE Box For EACH)

	Not At All Important				Very Important
Protecting jobs and economic opportunities	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Protecting property values	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Protecting the environment	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐

12. When the government passes a law about endangered species, wetlands or tree preservation etc., do you think that affected property owners should receive financial compensation from government because it prevents them from using their property? (X ONE Box)

1 ☐ Definitely yes
2 ☐ Maybe
3 ☐ Definitely no
4 ☐ Not sure

13a. How would you rate the following government actions using a scale of 1 to 5, where "1" means "lowest priority" and "5" means "highest priority" in terms of improving the quality of life in your community? (X ONE Box For EACH)

	Lowest Priority				Highest Priority
Encouraging new jobs	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Improving the education system	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Reforming the welfare system	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Providing for national defense	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Protecting the environment and wildlife	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Promoting decent and affordable housing for all Americans	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Improving the future for children living in poverty	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Fighting crime	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Providing adequate infrastructure (i.e., roads, dams, etc.)	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Managing growth	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Keeping taxes low	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐

13b. Please rate the job being done by the government in each of the following areas using a scale of 1 to 5 where "1" means "very poor" and "5" means "excellent". (X ONE Box For EACH)

	Very Poor				Excellent
Encouraging new jobs	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Improving the education system	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Reforming the welfare system	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Providing for national defense	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Protecting the environment and wildlife	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Promoting decent and affordable housing for all Americans	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Improving the future for children living in poverty	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Fighting crime	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Providing adequate infrastructure (i.e., roads, dams, etc.)	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Managing growth	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Keeping taxes low	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐

14. Should the government be required to conduct a cost-benefit analysis before imposing government regulations that raise the cost of housing? (X ONE Box)

1 ☐ Yes 2 ☐ No 3 ☐ Not sure

15. When costs for development of new infrastructure are imposed (impact fees, etc.) the builder/developer pays for it and passes it on to new home buyers. Please rate your preference as to who should bear the cost of new infrastructure. (X ONE Box)

	Least Prefer				Most Prefer
New home buyers	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
All taxpayers	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐

16. If you are purchasing a home and you are given an extra $2,000 to spend, which of the following would you choose? (X ONE Box)

1 ☐ Upgraded or improved energy-efficient appliances and insulation
2 ☐ Upgraded kitchen quality
3 ☐ Upgraded appliances
4 ☐ Larger counter space in kitchen
5 ☐ Central cooking island
6 ☐ More landscaping
7 ☐ Built-in recycling bins
☐ Other (Specify): _____

Q1. WHEN YOU BOUGHT YOUR LAST HOME DID ENVIRONMENTAL ISSUES INFLUENCE YOUR PURCHASE DECISION ?
(PERCENT OF RESPONDENTS)

		FOUR CENSUS REGIONS				OWNER OR RENTER		COMBINED HOUSEHOLD INCOME				AGE OF THE HEAD OF THE HOUSEHOLD			CONSIDER YOURSELF AN ENVIRONMENTALIST		
	Total	North-east	Midwest	South	West	Owner	Renter	Less than $50,000	$50,000 to $74,999	$75,000 to $99,999	$100,000 or more	Less than 35 years	35 to 54 years	55 years or more	Yes	No	Don't know
Greatly	9%	7%	8%	13%	8%	10%	7%	7%	10%	5%	16%	8%	9%	13%	17%	5%	9%
Somewhat	39	39	38	41	39	39	42	41	35	44	38	39	39	42	51	30	45
Not at all	51	54	54	46	53	51	51	51	54	51	46	53	52	45	32	65	45
Not applicable (as a % of respondents)	36	37	43	31	38	10	191	49	39	24	21	89	30	20	31	34	51

Q2. IF YOU BUY A HOME IN THE FUTURE, HOW MUCH WILL ENVIRONMENTAL ISSUES INFLUENCE YOUR PURCHASE DECISION ?
(PERCENT OF RESPONDENTS)

		FOUR CENSUS REGIONS				OWNER OR RENTER		COMBINED HOUSEHOLD INCOME				AGE OF THE HEAD OF THE HOUSEHOLD			CONSIDER YOURSELF AN ENVIRONMENTALIST		
	Total	North-east	Midwest	South	West	Owner	Renter	Less than $50,000	$50,000 to $74,999	$75,000 to $99,999	$100,000 or more	Less than 35 years	35 to 54 years	55 years or more	Yes	No	Don't know
Greatly	21%	17%	17%	27%	22%	21%	21%	21%	20%	16%	29%	15%	21%	31%	40%	13%	16%
Somewhat	65	74	66	61	59	64	66	67	65	67	58	64	66	61	54	66	74
Not at all	14	9	17	12	19	14	13	12	16	17	13	21	13	8	5	21	10

Q3. HOW OFTEN DO YOU DO THE FOLLOWING?
(PERCENT OF RESPONDENTS) - (CONT.)

		FOUR CENSUS REGIONS				OWNER OR RENTER		COMBINED HOUSEHOLD INCOME				AGE OF THE HEAD OF THE HOUSEHOLD			CONSIDER YOURSELF AN ENVIRONMENTALIST		
	Total	North-east	Midwest	South	West	Owner	Renter	Less than $50,000	$50,000 to $74,999	$75,000 to $99,999	$100,000 or more	Less than 35 years	35 to 54 years	55 years or more	Yes	No	Don't know
Patronize companies with good environmental records																	
Never	7	3	6	11	8	6	10	7	9	5	6	14	6	5	3	8	9
Once in a while	26	24	31	20	29	26	25	24	25	30	25	26	27	20	12	33	26
Sometimes	54	62	49	54	51	53	56	55	53	54	52	54	53	56	57	54	51
Always	13	11	14	15	12	15	9	13	13	11	17	6	14	19	28	5	14
Use environmentally friendly products																	
Never	2	1	1	3	3	2	3	2	3	4	1	4	2	-	1	3	2
Once in a while	16	15	18	15	17	16	18	19	14	9	21	19	17	10	8	23	13
Sometimes	65	71	64	62	64	65	65	64	68	71	56	65	65	66	62	65	69
Always	16	13	17	19	16	17	14	15	15	16	22	12	16	24	29	9	16
Volunteer or work for environmental group																	
Never	70	68	70	70	69	69	70	73	64	70	66	77	68	63	45	82	70
Once in a while	20	23	20	18	20	20	21	17	24	18	23	17	21	22	33	13	19
Sometimes	8	6	8	8	8	8	7	7	9	11	5	6	7	12	14	3	10
Always	3	3	1	3	3	3	2	3	3	-	5	1	3	3	8	1	1
Other																	
Never	51	71	50	61	29	49	55	63	56	40	29	65	46	45	30	62	55
Once in a while	18	21	6	6	33	17	18	7	22	40	14	12	15	36	15	21	18
Sometimes	15	-	31	17	14	15	18	19	6	10	29	6	20	18	15	10	23
Always	15	7	13	17	24	19	9	11	17	10	29	18	20	-	40	7	5

Q3. HOW OFTEN DO YOU DO THE FOLLOWING?
(PERCENT OF RESPONDENTS)

		FOUR CENSUS REGIONS				OWNER OR RENTER		COMBINED HOUSEHOLD INCOME				AGE OF THE HEAD OF THE HOUSEHOLD			CONSIDER YOURSELF AN ENVIRONMENTALIST		
	Total	North-east	Midwest	South	West	Owner	Renter	Less than $50,000	$50,000 to $74,999	$75,000 to $99,999	$100,000 or more	Less than 35 years	35 to 54 years	55 years or more	Yes	No	Don't know
Take public transportation to work																	
Never	87%	74%	87%	94%	89%	89%	81%	91%	90%	84%	75%	90%	86%	86%	78%	90%	91%
Once in a while	7	14	6	4	7	6	10	6	6	9	9	4	8	8	11	6	5
Sometimes	3	5	4	2	2	3	4	2	2	2	8	3	3	2	5	2	2
Always	3	8	3	1	3	2	5	1	2	5	7	2	3	4	6	2	2
Share ride/car pool to work																	
Never	67	68	73	67	61	68	64	66	68	68	68	63	66	76	61	72	64
Once in a while	20	19	20	19	24	18	24	22	18	20	19	23	21	12	24	19	19
Sometimes	9	8	6	11	10	10	7	8	9	8	10	10	9	8	10	6	13
Always	4	5	1	4	6	4	4	4	5	3	3	4	4	4	4	3	5
Drive to work alone																	
Never	12	16	14	10	11	12	13	13	11	13	13	8	12	20	8	12	17
Once in a while	4	9	4	3	5	5	3	4	3	6	7	4	5	2	7	4	2
Sometimes	16	14	9	21	18	16	17	18	16	15	14	14	18	13	19	14	18
Always	67	62	73	66	67	67	67	66	69	67	66	74	66	65	66	70	63
Recycle waste																	
Never	4	-	8	5	4	4	6	5	6	1	4	5	4	3	2	5	5
Once in a while	10	3	14	15	4	9	12	15	8	5	5	13	9	7	5	11	12
Sometimes	33	19	34	39	35	31	37	35	31	36	25	38	31	30	25	39	27
Always	54	78	44	42	56	57	46	45	55	58	67	44	55	60	68	45	57
Conserve home energy use																	
Never	1	2	1	1	-	1	2	1	1	1	2	-	2	-	1	2	-
Once in a while	5	2	12	4	5	4	9	5	6	4	6	9	5	2	3	6	8
Sometimes	41	39	43	44	38	41	41	39	40	48	41	55	39	33	24	49	43
Always	53	57	44	51	57	54	48	55	53	46	50	36	54	65	73	43	49
Conserve water																	
Never	3	3	5	3	1	2	6	4	3	2	2	6	3	-	2	4	2
Once in a while	9	7	16	6	8	7	14	10	11	6	7	14	9	4	6	10	11
Sometimes	47	49	47	48	42	48	44	44	42	52	55	46	48	43	30	54	50
Always	41	40	32	42	49	44	36	42	44	40	36	33	41	53	63	32	37

Q4A. DID YOU CHECK THE ENVIRONMENTAL RECORD OF THE BUILDER BEFORE YOU BOUGHT YOUR LAST HOME?
(PERCENT OF RESPONDENTS)

		FOUR CENSUS REGIONS				OWNER OR RENTER	COMBINED HOUSEHOLD INCOME				AGE OF THE HEAD OF THE HOUSEHOLD			CONSIDER YOURSELF AN ENVIRONMENTALIST		
	Total	North-east	Midwest	South	West	Owner	Less than $50,000	$50,000 to $74,999	$75,000 to $99,999	$100,000 or more	Less than 35 years	35 to 54 years	55 years or more	Yes	No	Don't know
Yes	4%	4%	4%	3%	6%	4%	2%	5%	5%	6%	3%	3%	11%	6%	2%	6%
No	96	96	96	97	94	96	98	95	95	94	97	97	89	94	98	94
Respondents	577	115	131	183	141	435	214	161	91	104	103	372	95	158	285	129

Q4B. WOULD YOU CHECK THE ENVIRONMENTAL RECORD OF A BUILDER BEFORE BUYING YOUR NEXT HOME?
(PERCENT OF RESPONDENTS)

		FOUR CENSUS REGIONS				OWNER OR RENTER		COMBINED HOUSEHOLD INCOME				AGE OF THE HEAD OF THE HOUSEHOLD			CONSIDER YOURSELF AN ENVIRONMENTALIST		
	Total	North-east	Midwest	South	West	Owner	Renter	Less than $50,000	$50,000 to $74,999	$75,000 to $99,999	$100,000 or more	Less than 35 years	35 to 54 years	55 years or more	Yes	No	Don't know
Yes	39%	43%	32%	43%	37%	36%	46%	44%	37%	31%	39%	35%	38%	52%	60%	29%	38%
No	61	57	68	57	63	64	54	56	63	69	61	65	62	48	40	71	63
Respondents	628	128	143	199	150	431	189	241	179	93	107	124	397	99	168	311	144

Q4C. WHAT METHODS WOULD YOU USE TO CHECK THE ENVIRONMENTAL RECORD OF A BUILDER ?
(PERCENT OF RESPONDENTS)

		FOUR CENSUS REGIONS				OWNER OR RENTER		COMBINED HOUSEHOLD INCOME				AGE OF THE HEAD OF THE HOUSEHOLD			CONSIDER YOURSELF AN ENVIRONMENTALIST		
	Total	North-east	Midwest	South	West	Owner	Renter	Less than $50,000	$50,000 to $74,999	$75,000 to $99,999	$100,000 or more	Less than 35 years	35 to 54 years	55 years or more	Yes	No	Don't know
Environmental organization....	54%	57%	60%	47%	59%	56%	52%	50%	54%	62%	60%	51%	57%	50%	67%	49%	46%
Friends.....	46	44	40	57	36	45	48	46	48	35	53	45	45	50	52	43	39
Newspaper/journals.....	34	33	31	40	30	37	31	33	30	43	37	30	36	32	38	32	29
Market Research.....	31	26	33	36	28	33	28	32	28	30	37	21	32	40	37	25	31
Marketing materials supplied by the builder.....	45	43	56	47	34	44	46	41	54	35	49	28	45	58	55	41	36
Local Home Builders Association.....	75	77	73	78	72	74	78	77	75	68	81	70	76	78	79	70	81
Other.....	7	13	4	5	7	7	7	6	8	8	7	4	8	6	7	9	5

Q6A. IF YOU WERE BUYING A HOME, WOULD YOU PURCHASE A HOME GUIDE EXPLAINING ENVIRONMENTAL PRODUCTS AND BUILDING TECHNOLOGIES ?
(PERCENT OF RESPONDENTS)

		FOUR CENSUS REGIONS				OWNER OR RENTER		COMBINED HOUSEHOLD INCOME				AGE OF THE HEAD OF THE HOUSEHOLD			CONSIDER YOURSELF AN ENVIRONMENTALIST		
	Total	North-east	Midwest	South	West	Owner	Renter	Less than $50,000	$50,000 to $74,999	$75,000 to $99,999	$100,000 or more	Less than 35 years	35 to 54 years	55 years or more	Yes	No	Don't know
Yes	29%	31%	27%	32%	28%	28%	31%	27%	29%	28%	36%	28%	29%	31%	46%	21%	28%
No	24	23	31	19	27	28	16	23	21	29	29	24	24	27	16	33	15
Not sure	46	47	42	49	46	43	53	50	49	44	35	48	46	43	38	46	57

Q7. RATE THE IMPORTANCE OF THE FOLLOWING ISSUES, FEATURES AND PRODUCTS/AMENITIES WHEN YOU BUY A NEW HOME IN A COMMUNITY ON A SCALE OF 1 TO 5
1 = NOT AT ALL IMPORTANT AND 5 = VERY IMPORTANT
(PERCENT OF RESPONDENTS)

		FOUR CENSUS REGIONS				OWNER OR RENTER		COMBINED HOUSEHOLD INCOME				AGE OF THE HEAD OF THE HOUSEHOLD			CONSIDER YOURSELF AN ENVIRONMENTALIST		
	Total	North-east	Midwest	South	West	Owner	Renter	Less than $50,000	$50,000 to $74,999	$75,000 to $99,999	$100,000 or more	Less than 35 years	35 to 54 years	55 years or more	Yes	No	Don't know
Energy efficiency of home																	
Not at all important 1	-	-	1%	-	1%	-	1%	-	-	-	2%	1%	-	1%	1%	-	-
2	1%	2%	-	1%	1	-	1	-	-	2%	1	-	1%	-	1	1%	-
3	5	5	4	6	5	5%	6	6%	3%	5	6	9	5	1	1	8	3%
4	14	17	18	8	15	13	17	13	14	13	16	22	13	8	8	18	12
Very important 5	80	77	77	86	78	82	76	81	83	80	75	69	81	90	89	73	85
Average rating	4.73	4.72	4.70	4.82	4.77	4.69	4.75	4.80	4.71	4.61	4.61	4.74	4.86	4.83	4.84	4.63	4.82
Indoor air quality																	
Not at all important 1	-	1%	1%	1%	-	1%	-	-	1%	-	1%	-	-	1%	-	1%	-
2	1%	1	1	1	3%	1	1%	1%	2	1%	1	1%	1%	1	1%	2	1%
3	8	8	4	9	10	8	7	7	6	11	9	11	9	2	5	11	4
4	20	23	24	15	19	17	25	21	20	16	20	24	19	15	17	23	17
Very important 5	71	67	69	75	68	72	67	70	72	71	69	64	70	81	77	63	79
Average rating	4.61	4.54	4.56	4.65	4.52	4.55	4.58	4.57	4.63	4.54	4.55	4.51	4.55	4.74	4.70	4.45	4.77
Price																	
Not at all important 1	-	-	1%	-	1%	-	-	-	-	-	2%	-	-	2%	1%	-	-
2	-	1%	-	-	-	-	-	-	-	2%	-	-	-	-	1	-	-
3	4%	7	2	1%	6	4%	3%	3%	3%	2	8	3%	4%	3	5	4%	1%
4	13	17	12	12	11	14	11	10	14	15	15	15	11	16	12	12	14
Very important 5	83	76	86	87	83	82	86	87	83	81	75	82	85	79	82	83	85
Average rating	4.79	4.71	4.85	4.86	4.78	4.78	4.83	4.84	4.80	4.75	4.61	4.79	4.81	4.70	4.75	4.78	4.84
Design and layout of house																	
Not at all important 1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	-	1%	1%	-	-	-	-	-	-	1%	1%	-	-	1%	-	1%	-
3	2%	6	1	-	1%	2%	3%	2%	2%	2	2	2%	2%	-	1%	2	2%
4	19	25	21	16%	17	16	26	23	19	16	13	31	17	11	16	18	22
Very important 5	79	68	78	84	82	82	71	75	79	81	85	67	80	88	83	79	76
Average rating	4.77	4.60	4.79	4.84	4.81	4.80	4.68	4.73	4.77	4.77	4.85	4.65	4.74	4.86	4.82	4.75	4.74
Location																	
Not at all important 1	-	-	1%	-	-	-	-	-	-	-	1%	-	-	1%	-	-	-
2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	2%	2%	1	2%	3%	2%	3%	2%	2%	2%	2	-	2%	3	2%	3%	-
4	16	21	14	15	16	16	17	20	11	18	16	24%	16	10	13	15	22%
Very important 5	82	76	84	83	82	82	80	79	87	80	81	76	82	86	85	82	78
Average rating	4.80	4.70	4.80	4.81	4.83	4.80	4.77	4.81	4.85	4.78	4.76	4.76	4.80	4.80	4.83	4.79	4.78

Q7. RATE THE IMPORTANCE OF THE FOLLOWING ISSUES, FEATURES AND PRODUCTS/AMENITIES WHEN YOU BUY A NEW HOME IN A COMMUNITY ON A SCALE OF 1 TO 5
1 = NOT AT ALL IMPORTANT AND 5 = VERY IMPORTANT
(PERCENT OF RESPONDENTS) - (CONT.)

		FOUR CENSUS REGIONS				OWNER OR RENTER		COMBINED HOUSEHOLD INCOME				AGE OF THE HEAD OF THE HOUSEHOLD			CONSIDER YOURSELF AN ENVIRONMENTALIST		
	Total	North-east	Midwest	South	West	Owner	Renter	Less than $50,000	$50,000 to $74,999	$75,000 to $99,999	$100,000 or more	Less than 35 years	35 to 54 years	55 years or more	Yes	No	Don't know
Preservation of existing trees																	
Not at all important 1	2%	1%	3%	1%	5%	2%	2%	2%	1%	1%	4%	4%	2%	1%	1%	4%	-
2	3	5	4	2	5	3	5	4	3	4	3	6	3	1	1	5	2%
3	16	21	14	13	18	14	20	18	17	16	8	21	16	9	6	22	14
4	32	31	32	33	32	32	34	34	29	39	28	33	34	25	30	34	32
Very important 5	47	43	46	53	42	50	39	42	50	39	58	36	45	65	62	35	52
Average rating	4.19	4.13	4.11	4.41	4.07	4.28	4.03	4.10	4.24	4.08	4.36	3.91	4.17	4.55	4.51	3.91	4.34
Preservation of existing wetlands																	
Not at all important 1	6%	3%	9%	5%	9%	7%	6%	7%	6%	5%	8%	10%	7%	2%	3%	11%	1%
2	9	11	7	8	11	7	13	8	10	13	6	10	10	5	2	14	5
3	19	16	22	15	25	19	20	22	19	18	17	23	19	16	10	24	20
4	28	31	23	33	21	27	29	30	26	28	25	30	27	26	27	26	33
Very important 5	38	38	39	38	34	40	32	33	39	36	44	28	37	51	57	25	41
Average rating	3.83	3.87	3.76	3.88	3.60	3.68	3.74	3.82	3.82	3.77	3.91	3.50	3.77	4.19	4.30	3.48	4.08
Adequacy of roads																	
Not at all important 1	1%	1%	1%	1%	1%	1%	1%	-	1%	-	2%	2%	-	2%	1%	1%	1%
2	-	-	-	1	-	-	-	-	1	1%	-	-	-	-	1	-	1
3	11	14	12	10	12	11	12	11%	10	14	13	15	12%	4	9	13	11
4	37	41	39	32	37	35	40	40	33	36	35	42	37	28	37	37	35
Very important 5	51	45	49	57	50	53	46	48	55	48	51	41	50	66	53	49	51
Average rating	4.37	4.32	4.38	4.46	4.35	4.39	4.27	4.33	4.40	4.28	4.36	4.20	4.34	4.56	4.43	4.33	4.31
Preservation of animal species and plant species which are endangered																	
Not at all important 1	5%	5%	4%	5%	7%	5%	6%	4%	5%	3%	10%	5%	5%	6%	2%	8%	3%
2	9	11	10	6	11	9	8	8	9	13	8	7	10	8	2	15	3
3	20	19	19	17	24	19	22	22	18	18	19	25	20	14	9	26	18
4	31	36	31	33	23	30	34	32	30	38	23	34	30	32	29	29	35
Very important 5	35	29	36	39	36	38	30	34	39	29	39	29	36	39	56	21	41
Average rating	3.82	3.73	3.85	3.95	3.73	3.90	3.74	3.84	3.92	3.80	3.61	3.75	3.85	3.87	4.29	3.37	4.08

Q7. RATE THE IMPORTANCE OF THE FOLLOWING ISSUES, FEATURES AND PRODUCTS/AMENITIES WHEN YOU BUY A NEW HOME IN A COMMUNITY ON A SCALE OF 1 TO 5
1 = NOT AT ALL IMPORTANT AND 5 = VERY IMPORTANT
(PERCENT OF RESPONDENTS) - (CONT.)

		FOUR CENSUS REGIONS				OWNER OR RENTER		COMBINED HOUSEHOLD INCOME				AGE OF THE HEAD OF THE HOUSEHOLD			CONSIDER YOURSELF AN ENVIRONMENTALIST		
	Total	North-east	Midwest	South	West	Owner	Renter	Less than $50,000	$50,000 to $74,999	$75,000 to $99,999	$100,000 or more	Less than 35 years	35 to 54 years	55 years or more	Yes	No	Don't know
New landscaping																	
Not at all important 1	5%	5%	5%	3%	7%	4%	5%	3%	4%	4%	8%	7%	3%	6%	7%	5%	3%
2	10	11	10	10	9	9	12	12	11	8	6	15	10	4	8	10	11
3	29	31	29	28	31	29	31	30	28	35	25	30	30	25	24	32	30
4	33	37	31	30	33	32	34	32	32	34	33	32	34	28	31	35	30
Very important 5	24	18	24	29	21	26	19	23	25	19	27	15	23	36	30	19	27
Average rating	3.64	3.58	3.56	3.72	3.55	3.67	3.53	3.60	3.63	3.56	3.62	3.30	3.64	3.81	3.69	3.56	3.70
Open space																	
Not at all important 1	2%	2%	1%	4%	-	2%	1%	-	2%	1%	5%	2%	2%	2%	2%	2%	2%
2	4	6	2	5	3%	3	6	6%	2	3	4	5	4	1	4	4	5
3	19	19	20	17	21	19	20	20	20	23	15	22	19	16	16	21	19
4	36	39	38	35	36	36	38	35	39	39	35	41	36	33	32	41	33
Very important 5	38	35	39	40	39	40	35	40	36	34	42	30	38	48	46	33	41
Average rating	4.01	4.02	4.12	4.05	4.08	4.09	4.00	4.00	4.02	4.02	4.08	3.92	4.01	4.24	4.16	4.02	4.06
Proximity to public transportation																	
Not at all important 1	2%	2%	1%	4%	-	2%	1%	-	2%	1%	5%	2%	2%	2%	2%	2%	2%
2	4	6	2	5	3%	3	6	6%	2	3	4	5	4	1	4	4	5
3	19	19	20	17	22	19	20	20	20	23	15	22	19	16	16	21	19
4	37	39	38	35	37	36	39	35	39	38	36	41	37	33	32	41	34
Very important 5	39	35	39	40	39	40	36	40	37	34	42	30	39	48	46	33	42
Average rating	4.10	4.02	4.12	4.05	4.15	4.09	4.09	4.12	4.07	3.98	4.12	3.92	4.10	4.24	4.16	4.02	4.15
Jogging and walking paths/trails																	
Not at all important 1	2%	2%	1%	4%	-	2%	1%	-	2%	1%	5%	2%	2%	2%	2%	2%	2%
2	4	6	2	5	3%	3	6	6%	2	3	4	5	4	1	3	4	5
3	19	19	20	17	21	19	20	19	20	23	15	21	19	16	16	21	19
4	36	39	37	34	36	36	38	34	39	38	36	40	36	32	32	40	33
Very important 5	38	35	39	39	39	39	35	39	36	34	42	29	38	47	45	33	41
Average rating	4.01	4.02	4.08	3.96	4.08	4.04	4.00	4.00	4.02	3.98	4.12	3.80	4.01	4.15	4.09	3.98	4.06

Q7. RATE THE IMPORTANCE OF THE FOLLOWING ISSUES, FEATURES AND PRODUCTS/AMENITIES WHEN YOU BUY A NEW HOME IN A COMMUNITY ON A SCALE OF 1 TO 5
1 = NOT AT ALL IMPORTANT AND 5 = VERY IMPORTANT
(PERCENT OF RESPONDENTS) - (CONT.)

		FOUR CENSUS REGIONS				OWNER OR RENTER		COMBINED HOUSEHOLD INCOME				AGE OF THE HEAD OF THE HOUSEHOLD			CONSIDER YOURSELF AN ENVIRONMENTALIST		
	Total	North-east	Midwest	South	West	Owner	Renter	Less than $50,000	$50,000 to $74,999	$75,000 to $99,999	$100,000 or more	Less than 35 years	35 to 54 years	55 years or more	Yes	No	Don't know
Lake																	
Not at all important 1	2%	2%	1%	4%	-	2%	1%	-	2%	1%	5%	2%	2%	2%	2%	2%	2%
2	4	6	2	5	3%	3	6	6%	2	3	4	5	4	1	4	4	5
3	19	19	20	17	22	19	20	20	20	23	15	22	19	17	16	21	19
4	37	40	38	35	37	36	38	35	39	39	37	40	37	34	33	41	34
Very important 5	39	35	39	40	39	40	35	40	36	34	43	30	39	50	46	33	42
Average rating	4.10	4.06	4.12	4.05	4.15	4.09	4.00	4.12	4.02	4.02	4.21	3.98	4.10	4.41	4.20	4.02	4.15
School district																	
Not at all important 1	22%	16%	17%	31%	21%	24%	17%	21%	22%	27%	21%	25%	23%	14%	16%	24%	25%
2	23	25	22	23	21	23	23	26	22	24	16	26	22	19	19	25	20
3	28	32	29	22	31	28	28	29	25	26	32	25	29	29	28	28	27
4	17	19	22	15	16	15	24	18	17	16	17	16	16	26	21	14	19
Very important 5	10	11	10	9	11	10	10	9	11	7	14	6	11	12	15	8	9
Average rating	2.70	2.93	2.86	2.48	2.75	2.64	2.93	2.77	2.64	2.52	2.87	2.46	2.73	3.03	2.97	2.54	2.67
Proximity to shopping																	
Not at all important 1	4%	8%	3%	3%	4%	5%	4%	2%	4%	7%	7%	6%	4%	5%	4%	3%	6%
2	8	8	6	8	8	7	9	7	7	8	9	10	8	2	10	6	7
3	30	31	36	25	29	29	30	34	30	22	27	31	30	26	30	29	34
4	37	37	33	40	37	37	37	38	36	40	35	35	38	37	35	39	36
Very important 5	21	16	23	23	22	21	21	19	23	22	22	18	20	29	21	23	18
Average rating	3.63	3.45	3.70	3.69	3.65	3.59	3.65	3.65	3.67	3.59	3.56	3.49	3.62	3.80	3.59	3.73	3.56
Recreation facilities																	
Not at all important 1	6%	7%	6%	5%	7%	7%	5%	5%	7%	4%	10%	6%	6%	5%	9%	5%	7%
2	10	14	10	8	10	9	13	11	9	11	9	13	10	8	8	12	11
3	38	40	38	40	37	39	39	47	36	32	30	37	39	42	37	40	38
4	29	26	31	31	30	29	31	26	27	39	34	32	30	25	28	31	27
Very important 5	15	14	15	17	16	16	13	12	21	14	17	11	16	20	19	13	18
Average rating	3.31	3.29	3.39	3.50	3.38	3.38	3.37	3.32	3.46	3.48	3.39	3.26	3.43	3.47	3.43	3.38	3.41
Safety																	
Not at all important 1	1%	2%	1%	-	1%	1%	1%	-	1%	1%	3%	-	-	4%	1%	1%	1%
2	-	2	-	-	-	-	1	-	1	1	1	-	1%	-	1	-	1
3	6	5	8	6%	7	5	9	7%	10	6	1	6%	7	6	6	8	3
4	19	22	23	14	21	20	18	18	21	19	19	26	18	17	19	20	16
Very important 5	74	69	69	81	71	74	72	76	68	73	76	69	75	73	73	71	80
Average rating	4.65	4.54	4.62	4.79	4.61	4.66	4.62	4.73	4.57	4.62	4.64	4.67	4.70	4.55	4.62	4.60	4.76

Q7. RATE THE IMPORTANCE OF THE FOLLOWING ISSUES, FEATURES AND PRODUCTS/AMENITIES WHEN YOU BUY A NEW HOME IN A COMMUNITY ON A SCALE OF 1 TO 5
1 = NOT AT ALL IMPORTANT AND 5 = VERY IMPORTANT
(PERCENT OF RESPONDENTS) - (CONT.)

		FOUR CENSUS REGIONS				OWNER OR RENTER		COMBINED HOUSEHOLD INCOME				AGE OF THE HEAD OF THE HOUSEHOLD			CONSIDER YOURSELF AN ENVIRONMENTALIST		
	Total	North-east	Midwest	South	West	Owner	Renter	Less than $50,000	$50,000 to $74,999	$75,000 to $99,999	$100,000 or more	Less than 35 years	35 to 54 years	55 years or more	Yes	No	Don't know
Other																	
Not at all important 1.....	10%	29%	7%	14%	-	6%	17%	11%	-	13%	14%	13%	9%	13%	-	10%	20%
2.....	2	14	-	-	-	-	6	6	-	-	-	-	3	-	-	-	7
3.....	2	-	-	-	7%	3	-	6	-	-	-	-	3	-	-	5	-
4.....	16	-	13	21	21	25	-	11	10%	38	14	25	15	13	14%	20	13
Very important 5.....	70	57	80	64	71	66	78	67	90	50	71	63	71	75	86	65	60
Average rating.....	4.25	3.42	4.59	4.18	4.60	4.45	4.19	4.20	4.90	4.15	4.25	4.28	4.39	4.40	4.86	4.21	3.68

Q8A. RATE THE IMPORTANCE OF THE FOLLOWING PRODUCTS AND AMENITIES WHEN YOU BUY A NEW HOME IN A COMMUNITY ON A SCALE OF 1 TO 5?
1 = NOT AT ALL IMPORTANT AND 5 = VERY IMPORTANT
(PERCENT OF RESPONDENTS)

		FOUR CENSUS REGIONS				OWNER OR RENTER		COMBINED HOUSEHOLD INCOME				AGE OF THE HEAD OF THE HOUSEHOLD			CONSIDER YOURSELF AN ENVIRONMENTALIST		
	Total	North-east	Midwest	South	West	Owner	Renter	Less than $50,000	$50,000 to $74,999	$75,000 to $99,999	$100,000 or more	Less than 35 years	35 to 54 years	55 years or more	Yes	No	Don't know
Building products manf. specially for chemically sensitive individuals, i.e. respiratory/allergy problems																	
Not at all important 1	12%	10%	12%	9%	16%	12%	10%	10%	12%	15%	13%	16%	11%	8%	8%	15%	9%
2	14	21	10	12	13	13	16	11	13	15	21	13	16	8	14	15	11
3	25	24	30	25	19	27	20	26	23	20	26	29	23	24	18	27	26
4	23	21	23	24	23	21	27	27	21	21	19	26	21	26	27	22	21
Very important 5	27	24	25	29	29	27	27	26	31	29	21	17	29	33	32	21	33
Average rating	3.42	3.28	3.39	3.49	3.36	3.38	3.45	3.48	3.46	3.34	3.14	3.18	3.41	3.65	3.58	3.19	3.58
Solar heating																	
Not at all important 1	19%	20%	21%	17%	17%	20%	15%	16%	20%	19%	21%	27%	17%	15%	8%	25%	17%
2	18	20	25	16	13	18	18	17	19	19	18	24	18	10	16	21	14
3	29	28	27	30	30	28	32	29	29	28	30	24	30	31	21	31	35
4	24	23	19	27	26	24	26	26	23	25	22	19	24	32	32	18	27
Very important 5	10	9	8	11	13	11	9	12	9	9	10	6	11	12	22	5	8
Average rating	2.88	2.81	2.68	3.02	3.02	2.91	2.96	3.01	2.82	2.86	2.85	2.53	2.94	3.16	3.41	2.57	3.98
Built-in recycling containers																	
Not at all important 1	17%	15%	20%	16%	19%	20%	13%	16%	17%	20%	19%	20%	17%	15%	13%	21%	16%
2	19	20	23	16	17	17	23	17	18	21	22	20	18	19	14	24	14
3	28	25	30	27	30	30	24	28	27	29	27	20	31	23	25	28	32
4	24	29	17	25	26	23	27	27	24	20	22	29	22	29	29	20	26
Very important 5	12	11	10	16	9	11	13	12	14	9	10	11	12	13	19	7	13
Average rating	2.95	3.01	2.74	3.09	2.92	2.91	3.04	3.02	3.00	2.74	2.82	2.91	2.94	3.03	3.27	2.68	3.09
Steel framing																	
Not at all important 1	15%	17%	14%	12%	18%	17%	11%	13%	16%	18%	14%	14%	18%	6%	14%	15%	17%
2	17	14	28	12	18	17	18	17	19	16	16	26	15	16	17	19	14
3	34	30	36	32	37	34	34	35	30	36	34	31	34	37	26	38	33
4	19	25	15	23	12	17	22	18	21	21	14	16	20	17	23	16	21
Very important 5	15	15	7	21	15	16	15	17	14	9	21	14	14	24	21	13	15
Average rating	3.02	3.10	2.73	3.29	2.88	3.01	3.12	3.09	2.98	2.87	3.09	2.93	3.00	3.37	3.23	2.96	3.03

Q8A. RATE THE IMPORTANCE OF THE FOLLOWING PRODUCTS AND AMENITIES WHEN YOU BUY A NEW HOME IN A COMMUNITY ON A SCALE OF 1 TO 5?
1 = NOT AT ALL IMPORTANT AND 5 = VERY IMPORTANT
(PERCENT OF RESPONDENTS) - (CONT.)

		FOUR CENSUS REGIONS				OWNER OR RENTER		COMBINED HOUSEHOLD INCOME				AGE OF THE HEAD OF THE HOUSEHOLD			CONSIDER YOURSELF AN ENVIRONMENTALIST		
	Total	North-east	Midwest	South	West	Owner	Renter	Less than $50,000	$50,000 to $74,999	$75,000 to $99,999	$100,000 or more	Less than 35 years	35 to 54 years	55 years or more	Yes	No	Don't know
Wood framing																	
Not at all important 1.....	10%	9%	8%	12%	12%	11%	7%	10%	8%	12%	13%	11%	11%	5%	8%	11%	10%
2.....	13	12	16	12	13	11	18	12	12	12	17	16	12	12	15	13	10
3.....	37	37	34	36	41	39	32	37	39	41	32	35	38	37	33	38	37
4.....	27	33	28	27	21	25	33	31	24	25	24	30	26	29	25	27	32
Very important 5.....	13	10	15	13	14	14	10	11	16	11	14	9	13	17	18	11	11
Average rating.....	3.20	3.26	3.29	3.17	3.15	3.20	3.21	3.24	3.25	3.14	3.09	3.13	3.18	3.41	3.27	3.14	3.24
Increased energy efficient appliances																	
Not at all important 1.....	1%	-	1%	1%	1%	1%	1%	-	1%	1%	1%	2%	-	-	1%	-	1%
2.....	1	1%	1	1	1	-	2	-	1	-	2	2	-	1%	1	1%	-
3.....	8	5	13	4	10	8	7	10%	6	6	7	11	7%	7	2	10	11
4.....	30	35	27	28	29	28	34	30	30	36	24	44	28	19	22	35	27
Very important 5.....	61	59	58	67	59	63	57	59	63	57	66	41	64	73	75	54	61
Average rating.....	4.52	4.52	4.40	4.62	4.44	4.52	4.47	4.18	4.56	4.48	4.52	4.20	4.53	4.64	4.72	4.42	4.47
Water conserving plumbing																	
Not at all important 1.....	2%	3%	3%	1%	1%	1%	3%	1%	2%	4%	2%	3%	1%	1%	1%	2%	3%
2.....	2	2	2	1	3	2	2	2	1	2	4	2	2	2	1	3	-
3.....	14	14	15	14	12	14	14	15	13	12	15	19	14	8	8	17	15
4.....	31	33	34	27	32	31	31	31	31	35	29	39	29	31	26	35	27
Very important 5.....	52	47	46	58	52	52	51	52	54	46	50	38	54	58	64	43	55
Average rating.....	4.32	4.16	4.18	4.43	4.31	4.31	4.28	4.34	4.37	4.14	4.21	4.10	4.33	4.43	4.51	4.14	4.31
Radon resistant construction technique																	
Not at all important 1.....	4%	3%	3%	4%	5%	4%	4%	2%	4%	5%	6%	5%	3%	4%	4%	5%	1%
2.....	6	5	4	6	7	6	5	4	6	8	7	6	6	5	3	9	3
3.....	16	17	16	14	16	17	13	15	12	19	20	17	15	16	10	21	12
4.....	26	24	31	27	21	24	29	29	32	24	13	35	24	23	20	26	32
Very important 5.....	49	51	46	49	51	49	49	50	47	44	55	35	52	52	63	40	50
Average rating.....	4.13	4.15	4.13	4.11	4.06	4.08	4.14	4.21	4.15	3.94	4.07	3.83	4.16	4.14	4.35	3.90	4.21

Q8A. RATE THE IMPORTANCE OF THE FOLLOWING PRODUCTS AND AMENITIES WHEN YOU BUY A NEW HOME IN A COMMUNITY ON A SCALE OF 1 TO 5?
1 = NOT AT ALL IMPORTANT AND 5 = VERY IMPORTANT
(PERCENT OF RESPONDENTS) - (CONT.)

		FOUR CENSUS REGIONS				OWNER OR RENTER		COMBINED HOUSEHOLD INCOME				AGE OF THE HEAD OF THE HOUSEHOLD			CONSIDER YOURSELF AN ENVIRONMENTALIST		
	Total	North-east	Midwest	South	West	Owner	Renter	Less than $50,000	$50,000 to $74,999	$75,000 to $99,999	$100,000 or more	Less than 35 years	35 to 54 years	55 years or more	Yes	No	Don't know
Water conserving landscaping																	
Not at all important 1.....	4%	6%	4%	2%	4%	3%	6%	3%	3%	5%	6%	5%	4%	2%	2%	6%	1%
2.....	6	6	6	5	9	6	7	7	7	2	10	9	6	6	4	9	4
3.....	20	22	26	19	14	20	20	22	19	22	17	24	20	16	11	25	20
4.....	33	35	34	32	30	34	30	30	37	35	30	37	32	31	33	31	38
Very important 5.....	37	30	30	41	43	37	36	39	35	36	37	26	38	45	51	29	36
Average rating.....	3.93	3.74	3.80	4.02	3.99	3.96	3.80	3.98	3.97	3.95	3.82	3.73	3.94	4.11	4.30	3.68	4.01
Water filtering system																	
Not at all important 1.....	4%	4%	4%	4%	5%	5%	4%	2%	4%	7%	7%	5%	4%	4%	3%	5%	4%
2.....	9	8	9	9	11	10	8	8	8	11	11	12	9	6	7	12	7
3.....	22	23	28	18	22	24	18	22	20	25	24	24	23	19	19	26	20
4.....	27	26	24	30	28	25	33	32	32	21	15	27	27	27	23	26	34
Very important 5.....	37	40	34	39	34	37	37	35	37	35	43	31	37	43	49	31	36
Average rating.....	3.81	3.93	3.72	3.91	3.75	3.83	3.91	3.87	3.93	3.63	3.76	3.64	3.84	3.96	4.11	3.66	3.94
Other																	
Not at all important 1.....	16%	17%	-	23%	17%	18%	11%	23%	-	-	25%	50%	13%	-	-	27%	22%
2.....	3	-	17%	-	-	5	-	-	20%	-	-	-	4	-	-	9	-
3.....	10	-	-	23	-	14	-	15	-	20%	-	25	8	-	-	9	22
4.....	16	17	17	8	33	18	11	8	20	40	13	25	13	33%	18%	9	22
Very important 5.....	55	67	67	46	50	45	78	54	60	40	63	-	63	67	82	45	33
Average rating.....	3.91	4.20	4.37	3.54	3.99	3.67	4.45	3.70	4.20	4.45	3.91	2.25	4.12	4.67	4.82	3.33	3.41

Q88. HOW WILLING YOU ARE TO PAY FOR EACH OF THE FOLLOWING PRODUCTS AND AMENITIES WHEN YOU BUY A NEW HOME IN A COMMUNITY ON A SCALE OF 1 TO 5
1 = NOT AT ALL WILLING AND 5 = VERY WILLING
(PERCENT OF RESPONDENTS)

		FOUR CENSUS REGIONS				OWNER OR RENTER		COMBINED HOUSEHOLD INCOME				AGE OF THE HEAD OF THE HOUSEHOLD			CONSIDER YOURSELF AN ENVIRONMENTALIST		
	Total	North-east	Midwest	South	West	Owner	Renter	Less than $50,000	$50,000 to $74,999	$75,000 to $99,999	$100,000 or more	Less than 35 years	35 to 54 years	55 years or more	Yes	No	Don't know
Building products manf. specially for chemically sensitive individuals, i.e. respiratory/allergy problems																	
Not at all important 1	16%	16%	20%	11%	19%	17%	13%	14%	14%	23%	18%	20%	16%	10%	10%	21%	13%
2	18	26	15	15	19	18	19	18	15	22	22	16	19	18	16	20	15
3	26	24	24	31	23	25	27	27	28	24	24	31	26	21	21	27	30
4	23	21	21	26	23	22	25	24	24	22	19	18	24	27	31	18	25
Very important 5	17	13	20	17	17	17	16	18	19	11	17	14	16	24	22	14	17
Average rating	3.07	2.89	3.06	3.23	3.03	3.01	3.12	3.17	3.19	2.82	2.95	2.87	3.08	3.37	3.39	2.84	3.18
Solar heating																	
Not at all important 1	18%	17%	25%	16%	15%	20%	15%	13%	20%	21%	23%	27%	16%	16%	9%	24%	18%
2	20	22	20	22	18	21	20	22	18	27	14	17	23	16	16	26	14
3	31	33	28	30	33	28	37	32	33	24	30	36	30	28	25	30	38
4	18	20	21	19	14	19	16	19	17	18	20	9	19	28	28	12	20
Very important 5	12	9	7	13	19	12	12	13	12	10	12	11	12	13	23	7	10
Average rating	2.83	2.85	2.68	2.91	3.01	2.82	2.90	2.94	2.83	2.69	2.81	2.60	2.88	3.09	3.43	2.49	2.90
Built-in recycling containers																	
Not at all important 1	24%	23%	30%	22%	24%	28%	18%	23%	23%	26%	29%	22%	25%	24%	18%	30%	19%
2	24	22	27	22	24	22	26	26	19	29	20	23	25	20	19	27	22
3	26	25	27	28	25	27	26	24	30	27	25	27	27	22	29	24	28
4	17	25	7	18	17	15	21	18	18	14	14	21	16	16	19	12	23
Very important 5	9	5	9	10	10	9	9	9	10	4	12	8	7	17	15	6	8
Average rating	2.63	2.67	2.38	2.72	2.65	2.58	2.77	2.64	2.73	2.41	2.60	2.73	2.55	2.79	2.94	2.34	2.79
Steel framing																	
Not at all important 1	16%	18%	23%	10%	16%	17%	13%	12%	17%	24%	16%	16%	17%	11%	10%	18%	18%
2	17	12	20	14	21	15	19	16	18	20	12	26	14	14	15	20	13
3	33	36	29	35	33	33	34	35	33	25	37	33	35	28	31	33	36
4	20	19	21	21	17	19	22	21	18	22	19	15	20	24	22	17	22
Very important 5	14	15	8	19	13	15	13	16	14	9	16	10	13	24	21	12	11
Average rating	2.99	3.01	2.74	3.22	2.90	2.97	3.06	3.13	2.94	2.72	3.07	2.77	2.95	3.39	3.26	2.85	2.95

Q88. HOW WILLING YOU ARE TO PAY FOR EACH OF THE FOLLOWING PRODUCTS AND AMENITIES WHEN YOU BUY A NEW HOME IN A COMMUNITY ON A SCALE OF 1 TO 5
1 = NOT AT ALL WILLING AND 5 = VERY WILLING
(PERCENT OF RESPONDENTS) - (CONT.)

		FOUR CENSUS REGIONS				OWNER OR RENTER		COMBINED HOUSEHOLD INCOME				AGE OF THE HEAD OF THE HOUSEHOLD			CONSIDER YOURSELF AN ENVIRONMENTALIST		
	Total	North-east	Midwest	South	West	Owner	Renter	Less than $50,000	$50,000 to $74,999	$75,000 to $99,999	$100,000 or more	Less than 35 years	35 to 54 years	55 years or more	Yes	No	Don't know
Wood framing																	
Not at all important 1	10%	11%	10%	10%	8%	10%	9%	7%	8%	14%	15%	10%	11%	7%	6%	13%	8%
2	15	14	15	12	19	14	18	15	17	13	12	18	15	13	14	17	11
3	35	36	33	36	36	35	36	36	36	33	35	37	37	26	30	35	41
4	25	28	21	26	22	25	24	28	21	22	23	24	22	35	29	22	26
Very important 5	15	11	21	15	14	16	14	13	18	17	14	11	16	18	21	13	14
Average rating	3.20	3.14	3.28	3.21	3.12	3.23	3.19	3.22	3.24	3.12	3.06	3.08	3.20	3.41	3.45	3.05	3.27
Increased energy efficient appliances																	
Not at all important 1	2%	2%	3%	1%	2%	1%	3%	1%	1%	4%	2%	5%	1%	-	1%	2%	1%
2	3	3	4	2	6	4	4	3	6	1	3	5	3	2%	2	5	1
3	15	16	21	10	15	13	18	14	14	17	17	16	15	13	8	19	14
4	33	31	30	33	38	33	33	37	30	32	31	37	35	21	32	33	34
Very important 5	47	48	43	54	40	49	42	45	49	46	47	37	46	64	57	40	50
Average rating	4.20	4.20	4.09	4.37	4.11	4.25	4.07	4.22	4.20	4.15	4.18	3.96	4.22	4.47	4.42	4.01	4.31
Water conserving plumbing																	
Not at all important 1	4%	5%	5%	2%	3%	3%	5%	3%	3%	4%	6%	6%	3%	2%	2%	5%	3%
2	5	5	6	3	7	5	4	4	7	5	4	5	5	3	2	7	3
3	21	29	23	17	18	19	25	23	17	22	22	32	19	15	13	26	20
4	33	24	35	35	36	33	33	34	32	39	28	30	35	28	36	31	34
Very important 5	37	37	30	44	36	40	32	36	41	30	40	28	37	52	47	31	40
Average rating	3.94	3.83	3.76	4.19	3.95	4.02	3.80	3.96	4.01	3.86	3.92	3.72	3.95	4.25	4.24	3.76	4.05
Radon resistant construction technique																	
Not at all important 1	9%	10%	10%	8%	9%	9%	10%	7%	10%	10%	12%	14%	9%	6%	4%	15%	4%
2	9	10	10	8	9	8	12	8	9	12	9	8	10	6	7	13	6
3	23	19	27	20	26	23	22	23	20	29	21	30	22	18	18	29	17
4	28	29	29	27	26	28	28	30	31	21	23	24	27	33	29	20	39
Very important 5	31	31	24	37	29	32	29	32	29	28	34	24	32	35	42	24	33
Average rating	3.63	3.49	3.38	3.77	3.54	3.66	3.48	3.72	3.48	3.36	3.55	3.36	3.63	3.79	3.98	3.28	3.88

Q38. HOW WILLING YOU ARE TO PAY FOR EACH OF THE FOLLOWING PRODUCTS AND AMENITIES WHEN YOU BUY A NEW HOME IN A COMMUNITY ON A SCALE OF 1 TO 5
1 = NOT AT ALL WILLING AND 5 = VERY WILLING
(PERCENT OF RESPONDENTS) - (CONT.)

		FOUR CENSUS REGIONS				OWNER OR RENTER		COMBINED HOUSEHOLD INCOME				AGE OF THE HEAD OF THE HOUSEHOLD			CONSIDER YOURSELF AN ENVIRONMENTALIST		
	Total	North-east	Midwest	South	West	Owner	Renter	Less than $50,000	$50,000 to $74,999	$75,000 to $99,999	$100,000 or more	Less than 35 years	35 to 54 years	55 years or more	Yes	No	Don't know
Wood framing																	
Not at all important 1.....	10%	11%	10%	10%	8%	10%	9%	7%	8%	14%	15%	10%	11%	7%	6%	13%	8%
2.....	15	14	15	12	19	14	18	15	17	13	12	18	15	13	14	17	11
3.....	35	36	33	36	36	35	36	36	36	33	35	37	37	26	30	35	41
4.....	25	28	21	26	22	25	24	28	21	22	23	24	22	35	29	22	26
Very important 5.....	15	11	21	15	14	16	14	13	18	17	14	11	16	18	21	13	14
Average rating.....	3.20	3.14	3.28	3.21	3.12	3.23	3.19	3.22	3.24	3.12	3.06	3.08	3.20	3.41	3.45	3.05	3.27
Increased energy efficient appliances																	
Not at all important 1.....	2%	2%	3%	1%	2%	1%	3%	1%	1%	4%	2%	5%	1%	-	1%	2%	1%
2.....	3	3	4	2	6	4	4	3	6	1	3	5	3	2%	2	5	1
3.....	15	16	21	10	15	13	18	14	14	17	17	16	15	13	8	19	14
4.....	33	31	30	33	38	33	33	37	30	32	31	37	35	21	32	33	34
Very important 5.....	47	48	43	54	40	49	42	45	49	46	47	37	46	64	57	40	50
Average rating.....	4.20	4.20	4.09	4.37	4.11	4.25	4.07	4.22	4.20	4.15	4.18	3.96	4.22	4.47	4.42	4.01	4.31
Water conserving plumbing																	
Not at all important 1.....	4%	5%	5%	2%	3%	3%	5%	3%	3%	4%	6%	6%	3%	2%	2%	5%	3%
2.....	5	5	6	3	7	5	4	4	7	5	4	5	5	3	2	7	3
3.....	21	29	23	17	18	19	25	23	17	22	22	32	19	15	13	26	20
4.....	33	24	35	35	36	33	33	34	32	39	28	30	35	28	36	31	34
Very important 5.....	37	37	30	44	36	40	32	36	41	30	40	28	37	52	47	31	40
Average rating.....	3.94	3.83	3.76	4.19	3.95	4.02	3.80	3.96	4.01	3.86	3.92	3.72	3.95	4.25	4.24	3.76	4.05
Radon resistant construction technique																	
Not at all important 1.....	9%	10%	10%	8%	9%	9%	10%	7%	10%	10%	12%	14%	9%	6%	4%	15%	4%
2.....	9	10	10	8	9	8	12	8	9	12	9	8	10	6	7	13	6
3.....	23	19	27	20	26	23	22	23	20	29	21	30	22	18	18	29	17
4.....	28	29	29	27	26	28	28	30	31	21	23	24	27	33	29	20	39
Very important 5.....	31	31	24	37	29	32	29	32	29	28	34	24	32	35	42	24	33
Average rating.....	3.63	3.49	3.38	3.77	3.54	3.66	3.48	3.72	3.48	3.36	3.55	3.36	3.63	3.79	3.98	3.28	3.88

Q88. HOW WILLING YOU ARE TO PAY FOR EACH OF THE FOLLOWING PRODUCTS AND AMENITIES WHEN YOU BUY A NEW HOME IN A COMMUNITY ON A SCALE OF 1 TO 5
1 = NOT AT ALL WILLING AND 5 = VERY WILLING
(PERCENT OF RESPONDENTS) - (CONT.)

		FOUR CENSUS REGIONS				OWNER OR RENTER		COMBINED HOUSEHOLD INCOME				AGE OF THE HEAD OF THE HOUSEHOLD			CONSIDER YOURSELF AN ENVIRONMENTALIST		
	Total	North-east	Midwest	South	West	Owner	Renter	Less than $50,000	$50,000 to $74,999	$75,000 to $99,999	$100,000 or more	Less than 35 years	35 to 54 years	55 years or more	Yes	No	Don't know
Water conserving landscaping																	
Not at all important 1.....	8%	10%	13%	4%	5%	6%	11%	8%	6%	10%	9%	10%	8%	5%	2%	11%	6%
2.....	12	17	13	9	9	12	12	12	14	8	12	13	11	12	10	14	9
3.....	28	27	29	30	26	27	30	29	28	31	24	31	29	21	23	32	27
4.....	28	29	28	30	27	30	25	30	27	33	24	31	28	27	32	23	34
Very important 5.....	24	17	17	26	32	25	22	22	25	18	32	16	24	35	32	20	24
Average rating.....	3.48	3.17	3.23	3.62	3.69	3.56	3.35	3.49	3.51	3.41	3.61	3.33	3.49	3.75	3.79	3.27	3.61
Water filtering system																	
Not at all important 1.....	7%	6%	9%	5%	7%	7%	7%	5%	7%	12%	7%	8%	7%	4%	4%	9%	5%
2.....	13	12	13	14	13	14	11	12	9	18	17	10	15	11	10	15	12
3.....	25	22	26	23	26	24	24	23	29	26	19	29	23	22	18	29	23
4.....	25	25	26	26	22	23	28	30	22	20	22	25	25	24	27	21	29
Very important 5.....	31	34	26	33	32	32	29	31	33	24	35	28	30	38	41	25	32
Average rating.....	3.63	3.66	3.47	3.71	3.59	3.59	3.58	3.73	3.65	3.26	3.61	3.55	3.56	3.78	3.91	3.35	3.74
Other																	
Not at all important 1.....	21%	50%	-	20%	20%	18%	29%	25%	-	25%	20%	25%	18%	33%	20%	10%	33%
2.....	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3.....	29	25	-	40	40	29	29	25	67%	50	-	50	29	-	-	40	33
4.....	17	-	20%	20	20	18	14	25	33	-	-	25	18	-	-	20	22
Very important 5.....	33	25	80	20	20	35	29	25	-	25	80	-	35	67	80	30	11
Average rating.....	3.41	2.05	4.08	3.02	3.02	3.52	3.17	3.25	3.33	3.00	4.20	2.75	3.52	3.68	4.20	3.60	2.75

Q16. IF YOU ARE PURCHASING A HOME AND YOU ARE GIVEN AN EXTRA $2,000 TO SPEND WHICH OF THE FOLLOWING WOULD YOU CHOOSE?
(PERCENT OF RESPONDENTS)

		FOUR CENSUS REGIONS				OWNER OR RENTER		COMBINED HOUSEHOLD INCOME				AGE OF THE HEAD OF THE HOUSEHOLD			CONSIDER YOURSELF AN ENVIRONMENTALIST		
	Total	North-east	Midwest	South	West	Owner	Renter	Less than $50,000	$50,000 to $74,999	$75,000 to $99,999	$100,000 or more	Less than 35 years	35 to 54 years	55 years or more	Yes	No	Don't know
Upgraded or improved energy-efficient appliances and insulation	66%	63%	60%	72%	66%	66%	65%	66%	68%	71%	57%	56%	67%	72%	72%	61%	67%
Upgraded kitchen quality	13	21	12	10	11	14	11	13	11	13	17	15	12	13	8	17	12
Upgraded appliances	3	2	4	4	4	3	5	3	3	2	6	6	3	1	4	4	3
Larger counter space in kitchen	3	3	3	3	5	3	4	3	3	5	5	5	3	3	2	5	1
Central cooking island	4	4	8	4	3	4	6	6	5	4	-	8	3	4	4	4	5
More landscaping	5	2	6	4	6	5	4	4	5	2	6	6	5	1	5	5	4
Built-in recycling bins	1	2	2	1	-	1	1	-	1	2	1	1	1	2	1	1	1
Other	4	4	6	4	5	4	5	5	3	1	7	3	5	4	5	3	7

Q18B. DO YOU THINK CHILDREN/GRANDCHILDREN WILL BE MORE CONCERNED ABOUT THE ENVIRONMENT IN PURCHASING A NEW HOME ?
(PERCENT OF RESPONDENTS)

		FOUR CENSUS REGIONS				OWNER OR RENTER		COMBINED HOUSEHOLD INCOME				AGE OF THE HEAD OF THE HOUSEHOLD			CONSIDER YOURSELF AN ENVIRONMENTALIST		
	Total	North-east	Midwest	South	West	Owner	Renter	Less than $50,000	$50,000 to $74,999	$75,000 to $99,999	$100,000 or more	Less than 35 years	35 to 54 years	55 years or more	Yes	No	Don't know
Yes	37%	35%	33%	41%	36%	37%	36%	38%	33%	37%	39%	39%	37%	31%	52%	31%	31%
Maybe	45	50	50	42	44	47	43	46	47	46	42	42	45	53	38	48	49
No	8	7	10	7	10	8	8	8	9	6	9	8	8	8	6	10	7
Not sure	10	8	8	10	10	8	13	8	11	10	9	11	9	8	4	11	12

Builders Survey of Environmental Issues 1996

(Based on 506 respondents)

Economics Department
National Association of Home Builders
Washington, D.C. 20005

NAHB

Builders Survey of Environmental Issues 1996

1. Please indicate the total number of residential units started by your firm during 1995.

   Single family (detached and attached) _____

   Multifamily (for sale and for rent) _____

   Total _____

2. Please indicate the total number of lots for residential construction started for development by your firm during 1995.

   Single family lots _____

   Lots for multifamily units _____

3. What is the estimated cost per finished lot for complying with federal, state and local environmental regulations (endangered species, wetlands mapping, environmental impact statements, impact fees, tree preservation, etc)?

   Endangered species $_____

   Stormwater drainage $_____

   Wetlands mapping $_____

   Environmental impact statements $_____

   Tree preservation $_____

   Ground water quality $_____

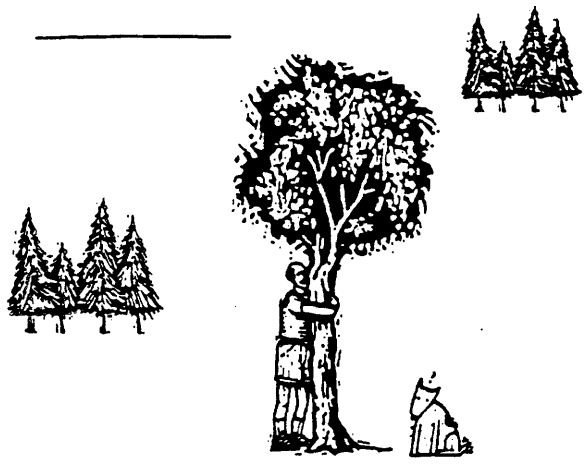
   Lead contamination $_____

   Other $_____

   Total $_____

4. How many trees, on average, did you plant for every lot you developed or home you built during 1995?

   _____



5. How much do you spend per house on tree conservation and replanting (working around existing trees, relocating existing trees, planting new trees on the lot) and how much premium buyers pay for a house on a wooded lot. (Check one box in each column or write in average amount.)

	You Spend	*Premium Buyers Pay for Wooded Lot*
Up to $1,000 per house	☐	☐
$1,000 - 3,000 per house	☐	☐
$3,000 - 5,000 per house	☐	☐
$5,001 - 7,500 per house	☐	☐
$7,501 - 10,000 per house	☐	☐
More than $10,000 per house	☐	☐
Not Applicable	☐	☐
Average per house	$_____	$_____

6. Has your firm in any way been affected (e.g., denied permits, or significantly increased production costs) due to any of the following issues within the past 12 months?

   ☐ Wetlands regulations
   ☐ Endangered species regulations
   ☐ Stormwater regulations
   ☐ Building codes
   ☐ Zoning regulations
   ☐ Subdivision regulations
   ☐ Erosion/sediment control
   ☐ Lead contamination
   ☐ Ground water quality
   ☐ Archaeological/historic preservation
   ☐ OSHA inspections
   ☐ Flood plain
   ☐ Building moratoria
   ☐ Growth controls
   ☐ School overcrowding
   ☐ Tree preservation
   ☐ Lack of infrastructure
   ☐ None of the above
   ☐ Other (specify) _____

7. **Have you taken any action to respond to environmental concerns in your community, such as an education program for school children or other public relations effort?**

☐ Yes ☐ No

If "yes," please attach a short description of your project or activity:

_____

_____

8. **What major changes have you made to comply with environmental regulations?**

☐ Increasing density

☐ Decreasing density

☐ Conserving trees and open spaces

☐ Adding extra infrastructure (water/sewer, roads, etc.)

☐ Offering energy-efficient product upgrades (low-e glass, more insulation, HVAC upgrades)

☐ Adding water-conserving products or landscaping

☐ Spending funds on attorneys, etc.

☐ Other (specify)_____

9. **There are at least four components to "building green." These are: increasing the energy efficiency of the home, using alternative building materials, recycling construction waste, and use of water conserving techniques.**

We are in the process of developing information about practices of NAHB builder members related to building green. Please check the methods and materials used by your firm when building homes:

	Yes	No
Energy Efficiency		
a. Ceiling and wall insulation use: Use significantly higher than required by codes.	☐	☐
b. Windows used: Super insulated	☐	☐
c. Seal all accessible duct seams/joints.	☐	☐
d. Use zoned HVAC system.	☐	☐
e. Install energy efficient appliances.	☐	☐
f. Orientation of the house for passive solar heating.	☐	☐
g. Other (specify)_____	☐	☐
Building Materials		
a. Use alternative to dimensional lumber. (Engineered wood products)	☐	☐
b. Use recycled and recyclable products.	☐	☐
c. Use locally produced materials/ products.	☐	☐
d. Specify materials to avoid waste.	☐	☐
e. Use durable materials.	☐	☐
f. Recycle construction waste.	☐	☐
g. Other (specify)_____	☐	☐
Water Conservation		
a. Use low flow shower heads. (max. 2-5 gallons per minute.)	☐	☐
b. Use water efficient landscaping.	☐	☐
c. Other (specify)_____	☐	☐
Land Development and Site Design		
a. Site selection process considered environmental factors, natural hazards or sensitive features such as flood plains, steep slopes, endangered species habitat, wetlands.	☐	☐
b. Retain/replace native vegetation	☐	☐
c. Minimized disruption to existing vegetation	☐	☐
d. Preserved visual corridors to reduce impact of development	☐	☐
e. Provided for zero net increase in storm water discharge from the site	☐	☐
f. Incorporate micro climatic variables into development	☐	☐
g. Provided access to mass transit	☐	☐
h. Reduce vehicle trip demand and trip distance by mixing land uses and providing a well-connected street network	☐	☐
i. Considered solar orientation in site design	☐	☐
g. Other (specify)_____	☐	☐

10. **How much do you spend per dwelling unit for scrap and waste removal and disposal? (Check one box or write in average amount.)**

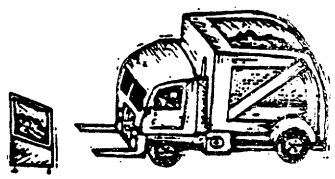
☐ Less than $250

☐ $250 - $499

☐ $500 - $749

☐ $750 - $1,000

☐ More than $1,000



Average per house $_____

11. **What waste removal and disposal processes do you typically use?**

☐ Contract with waste hauler to provide an on-site dumpster for all waste.

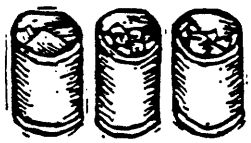
☐ Contract with waste hauler to provide waste removal without an on-site dumpster.

☐ Waste removal and disposal with your crews and equipment.

☐ Subcontractors are responsible for waste removal.

☐ Other (specify) _____

12. Which materials do you separate and reclaim from your waste stream? (Check all that apply.)



- ☐ Cardboard
- ☐ Metals
- ☐ Paint
- ☐ Clean dimensional lumber
- ☐ Gypsum
- ☐ Treated lumber
- ☐ Plastic
- ☐ Other (specify)_____

13. What do you do to mitigate wetland problems? (Check all that apply.)

- ☐ Avoid wetland
- ☐ Mitigation banking
- ☐ On-site mitigation
- ☐ Other (specify)_____

14. Which of the following statements best describes your own feelings about the system of controls on growth and residential development in the area where you build? (Check one box.)

- ☐ Too restrictive
- ☐ Not sufficient
- ☐ Just about right
- ☐ Not sure

15. What environmental amenities do your home buyers want in the home you build? (Check all that apply.)

- ☐ Allergin-free, chemical-free building materials
- ☐ Solar heating
- ☐ Recycling containers built-in
- ☐ Alternative products to wood
- ☐ Increased energy efficient appliances
- ☐ Water conserving appliances and plumbing
- ☐ Wooded lots
- ☐ Lower density
- ☐ Building products that cause no environmental harm when extracted from earth
- ☐ Building products that cause no known negative health impact to occupants
- ☐ Radon resistant construction techniques/radon abatement
- ☐ Water conserving landscaping
- ☐ Open space
- ☐ Water filtering system
- ☐ Other (specify)_____

16. When you develop land or purchase developed lots, which of the following opinions are applicable? (Check all that apply.)

- ☐ Preserve open space by building on smaller lots and/or cluster development in a single area
- ☐ Leave as many trees as possible
- ☐ Plant more trees
- ☐ Build more energy efficient homes and equip them with energy saving appliances
- ☐ Make greater use of recycled materials when building a house
- ☐ Minimize site disruption
- ☐ Other (specify) _____

17. Have you built or are you planning to build a sustainable development (sustainable development is one which conserves energy, uses less water, and uses materials which are not toxic, etc.)?

- ☐ Currently building
- ☐ Plan to build
- ☐ No plans

18. Do your customers ever ask about environmental features in a home?

a. ☐ Often
- ☐ Seldom
- ☐ Never

b. If you checked "Often" or "Seldom," what features do they inquire about?

_____

_____

_____

19. Would you be interested in learning more about the costs of providing environmental features?

- ☐ Yes
- ☐ No
- ☐ Maybe

20. Would you consider participating in a sustainable building or best management practice building program?

- ☐ Yes
- ☐ No
- ☐ Maybe

21 If you were labeled an environmental builder, would that be:

- ☐ Good
- ☐ Bad
- ☐ No difference

22. **What in your opinion are major drawbacks to environmental building?**

- ☐ Not enough information about or availability of environmental building products.
- ☐ Too expensive, making builders less competitive in local market.
- ☐ Don't know techniques
- ☐ Consumers do not care
- ☐ Consumer not willing to pay any additional cost.
- ☐ Takes more time
- ☐ Other (specify)_____

23. **Would you be interested in attending a seminar to learn techniques for marketing the environmental features of homes?**

- ☐ Yes
- ☐ No
- ☐ Maybe

24. **Would you have any interest in participating in a voluntary environmental certification program?**

- ☐ Very interested
- ☐ Somewhat interested
- ☐ Not interested

25. **Please state three examples of how builders or developer contribute positively to preserving or improving the environment.**

a._____

b._____

c._____

26. **Are there any other environmental issues that are not covered here or any comments you would like to make about the survey?**

_____

_____

_____

_____

_____

_____

_____

_____

Thank you for completing the Builders Survey of Environmental Issues. Please return it as soon as possible in the envelope enclosed to:

Economics Department
National Association of Home Builders
1201 Fifteenth Street, NW
Washington, D.C. 20005-2800

Q8. MAJOR CHANGES MADE TO COMPLY WITH ENVIRONMENTAL REGULATIONS
(PERCENT OF RESPONDENTS)

	Total	FOUR CENSUS REGIONS				PRINCIPAL OPERATION OF THE FIRM		SIZE OF THE FIRM					TAKE ACTION TO RESPOND TO ENVIRONMENTAL CONCERNS		BUILD SUSTAINABLE DEVELOPMENT OR PLAN TO BUILD		
								BUILDER			LAND DEVELOPER						
		North-east	Midwest	South	West	Builder	Land Developer	Small	Medium	Large	Less than 100 lots	100 lots or more	Yes	No	Currently building	Plan to build	No plans
Increasing density.....	14%	9%	5%	13%	27%	13%	16%	6%	22%	28%	12%	21%	20%	12%	16%	19%	12%
Decreasing density.....	24	32	24	26	19	17	42	11	33	28	37	55	30	24	23	25	22
Conserving trees and open spaces.....	51	60	49	57	41	46	64	39	59	67	62	70	59	49	61	67	46
Adding extra infrastructure (water/sewer, roads, etc.).....	34	43	38	31	30	28	50	21	39	54	48	49	38	33	39	33	34
Offering energy-efficient product upgrades (low-e glass, more insulation, HVAC upgrades).....	51	53	54	48	49	62	24	67	52	54	22	23	42	53	59	56	52
Adding water-conserving products or landscaping.....	35	26	34	34	44	39	26	40	22	56	20	30	34	34	57	50	30
Spending funds on attorneys, etc.....	33	36	29	34	35	24	56	17	37	36	52	62	47	31	38	33	31
Other.....	8	9	7	7	11	8	8	5	11	10	7	11	11	8	4	-	8
Respondents.....	407	47	114	144	96	284	119	185	46	39	60	47	64	331	56	36	277

Q8. MAJOR CHANGES MADE TO COMPLY WITH ENVIRONMENTAL REGULATIONS (PERCENT OF RESPONDENTS)

	Total	FOUR CENSUS REGIONS				PRINCIPAL OPERATION OF THE FIRM		SIZE OF THE FIRM					TAKE ACTION TO RESPOND TO ENVIRONMENTAL CONCERNS		BUILD SUSTAINABLE DEVELOPMENT OR PLAN TO BUILD		
								BUILDER			LAND DEVELOPER						
		North-east	Midwest	South	West	Builder	Land Developer	Small	Medium	Large	Less than 100 lots	100 lots or more	Yes	No	Currently building	Plan to build	No plans
Increasing density.....	14%	9%	5%	13%	27%	13%	16%	6%	22%	28%	12%	21%	20%	12%	16%	19%	12%
Decreasing density.....	24	32	24	26	19	17	42	11	33	28	37	55	30	24	23	25	22
Conserving trees and open spaces.....	51	60	49	57	41	46	64	39	59	67	62	70	59	49	61	67	46
Adding extra infrastructure (water/sewer, roads, etc.).....	34	43	38	31	30	28	50	21	39	54	48	49	38	33	39	33	34
Offering energy-efficient product upgrades (low-e glass, more insulation, HVAC upgrades).....	51	53	54	48	49	62	24	67	52	54	22	23	42	53	59	56	52
Adding water-conserving products or landscaping.....	35	26	34	34	44	39	26	40	22	56	20	30	34	34	57	50	30
Spending funds on attorneys, etc.....	33	36	29	34	35	24	56	17	37	36	52	62	47	31	38	33	31
Other.....	8	9	7	7	11	8	8	5	11	10	7	11	11	8	4	-	8
Respondents.....	407	47	114	144	96	284	119	185	46	39	60	47	64	331	56	36	277

Q9. METHODS AND MATERIALS USED FOR BUILDING GREEN - ENERGY EFFICIENCY (PERCENT OF RESPONDENTS)

	Total	FOUR CENSUS REGIONS				PRINCIPAL OPERATION OF THE FIRM		SIZE OF THE FIRM					TAKE ACTION TO RESPOND TO ENVIRONMENTAL CONCERNS		BUILD SUSTAINABLE DEVELOPMENT OR PLAN TO BUILD		
								BUILDER			LAND DEVELOPER						
		North-east	Midwest	South	West	Builder	Land Developer	Small	Medium	Large	Less than 100 lots	100 lots or more	Yes	No	Currently building	Plan to build	No plans
Ceiling and wall insulation: Significantly higher than required bycodes																	
Yes	71%	73%	77%	71%	61%	71%	72%	77%	59%	53%	71%	71%	74%	70%	84%	82%	67%
No	29	27	23	29	39	29	28	23	41	47	29	29	26	30	16	18	33
Respondents	412	48	125	150	83	336	72	225	54	43	35	28	53	348	51	38	299
Super insulated windows used																	
Yes	56%	65%	63%	42%	66%	55%	61%	64%	37%	29%	65%	52%	63%	55%	80%	62%	52%
No	44	35	38	58	34	45	39	36	63	71	35	48	37	45	20	38	48
Respondents	401	48	120	144	83	327	70	218	54	41	34	27	52	341	50	37	292
Seal all accessible duct seams/joints																	
Yes	80%	74%	66%	93%	80%	81%	77%	81%	77%	82%	82%	81%	92%	79%	90%	83%	77%
No	20	26	34	7	20	19	23	19	23	18	18	19	8	21	10	17	23
Respondents	405	47	114	150	87	330	70	223	53	39	33	27	50	347	51	35	297
Use zoned HVAC system																	
Yes	57%	67%	49%	67%	46%	58%	52%	63%	48%	44%	50%	63%	67%	57%	68%	73%	53%
No	43	33	51	33	54	42	48	38	52	56	50	38	33	43	32	27	47
Respondents	378	46	111	137	78	312	62	208	52	39	28	24	48	322	47	30	283
Install energy efficient appliances																	
Yes	85%	85%	89%	87%	78%	85%	87%	90%	69%	85%	90%	86%	94%	84%	94%	95%	81%
No	15	15	11	13	22	15	13	10	31	15	10	14	6	16	6	5	19
Respondents	404	47	117	150	83	331	68	221	54	41	30	28	51	342	51	37	293

Q9. METHODS AND MATERIALS USED FOR BUILDING GREEN - ENERGY EFFICIENCY (PERCENT OF RESPONDENTS) - (CONT.)

	Total	FOUR CENSUS REGIONS				PRINCIPAL OPERATION OF THE FIRM		SIZE OF THE FIRM					TAKE ACTION TO RESPOND TO ENVIRONMENTAL CONCERNS		BUILD SUSTAINABLE DEVELOPMENT OR PLAN TO BUILD		
								BUILDER			LAND DEVELOPER						
		North-east	Midwest	South	West	Builder	Land Developer	Small	Medium	Large	Less than 100 lots	100 lots or more	Yes	No	Currently building	Plan to build	No plans
Orientation of the house for passive solar heating																	
Yes	29%	33%	31%	20%	40%	30%	28%	37%	18%	13%	22%	38%	34%	28%	50%	35%	25%
No	71	67	69	80	60	70	72	63	82	87	78	63	66	72	50	65	75
Respondents	348	39	103	122	78	286	58	184	50	39	27	24	41	299	40	26	264
Other																	
Yes	38%	33%	38%	20%	55%	43%	20%	37%	67%	50%	-	-	50%	34%	45%	-	34%
No	62	67	63	80	45	57	80	63	33	50	100%	100%	50	66	55	100%	66
Respondents	58	6	16	15	20	47	10	35	3	8	3	4	8	47	11	1	44

Q9. METHODS AND MATERIALS USED FOR BUILDING GREEN - BUILDING MATERIALS
(PERCENT OF RESPONDENTS)

	Total	FOUR CENSUS REGIONS				PRINCIPAL OPERATION OF THE FIRM		SIZE OF THE FIRM					TAKE ACTION TO RESPOND TO ENVIRONMENTAL CONCERNS		BUILD SUSTAINABLE DEVELOPMENT OR PLAN TO BUILD		
								BUILDER			LAND DEVELOPER						
		North-east	Midwest	South	West	Builder	Land Developer	Small	Medium	Large	Less than 100 lots	100 lots or more	Yes	No	Currently building	Plan to build	No plans
Use alternative to dimensional lumber																	
Yes	75%	63%	80%	71%	77%	77%	61%	80%	62%	83%	59%	61%	74%	75%	81%	79%	72%
No	25	37	20	29	23	23	39	20	38	18	41	39	26	25	19	21	28
Respondents	385	43	117	140	79	319	62	213	53	40	29	23	47	328	48	34	281
Use recycled and recyclable products																	
Yes	61%	64%	65%	59%	55%	61%	59%	64%	52%	55%	56%	58%	69%	58%	87%	78%	53%
No	39	36	35	41	45	39	41	36	48	45	44	42	31	42	13	22	47
Respondents	375	44	113	135	76	311	59	207	50	40	27	24	49	319	47	32	279
Use locally produced materials/products																	
Yes	66%	51%	62%	72%	70%	65%	70%	68%	60%	57%	66%	85%	80%	64%	84%	85%	60%
No	34	49	38	28	30	35	30	32	40	43	34	15	20	36	16	15	40
Respondents	368	39	105	139	80	300	64	202	50	35	29	26	49	311	45	33	273
Specify materials to avoid waste																	
Yes	84%	76%	83%	86%	86%	84%	84%	87%	77%	82%	85%	87%	96%	82%	96%	88%	81%
No	16	24	17	14	14	16	16	13	23	18	15	13	4	18	4	13	19
Respondents	386	46	110	144	80	323	58	218	53	39	26	23	47	333	46	32	287
Use durable materials																	
Yes	89%	88%	89%	91%	88%	90%	89%	92%	84%	92%	93%	87%	98%	88%	93%	94%	88%
No	11	12	11	9	12	10	11	8	16	8	7	13	2	12	7	6	12
Respondents	381	42	114	141	78	315	61	211	51	39	29	23	48	327	43	34	284

Q9. METHODS AND MATERIALS USED FOR BUILDING GREEN - BUILDING MATERIALS (PERCENT OF RESPONDENTS) - (CONT.)

	Total	FOUR CENSUS REGIONS				PRINCIPAL OPERATION OF THE FIRM		SIZE OF THE FIRM					TAKE ACTION TO RESPOND TO ENVIRONMENTAL CONCERNS		BUILD SUSTAINABLE DEVELOPMENT OR PLAN TO BUILD		
								BUILDER			LAND DEVELOPER						
		North-east	Midwest	South	West	Builder	Land Developer	Small	Medium	Large	Less than 100 lots	100 lots or more	Yes	No	Currently building	Plan to build	No plans
Recycle construction waste																	
Yes	43%	35%	50%	32%	57%	44%	37%	48%	40%	24%	34%	38%	50%	42%	62%	57%	37%
No	57	65	50	68	43	56	63	52	60	76	66	63	50	58	38	43	63
Respondents	363	40	108	134	75	298	60	196	50	38	29	24	46	310	42	28	273
Other																	
Yes	30%	33%	14%	24%	44%	30%	20%	24%	67%	25%	40%	-	38%	30%	43%	50%	26%
No	70	67	86	76	56	70	80	76	33	75	60	100%	63	70	57	50	74
Respondents	54	6	14	17	16	43	10	33	3	4	5	4	8	44	7	4	42

Q9. METHODS AND MATERIALS USED FOR BUILDING GREEN - WATER CONSERVATION
(PERCENT OF RESPONDENTS)

	Total	FOUR CENSUS REGIONS				PRINCIPAL OPERATION OF THE FIRM		SIZE OF THE FIRM					TAKE ACTION TO RESPOND TO ENVIRONMENTAL CONCERNS		BUILD SUSTAINABLE DEVELOPMENT OR PLAN TO BUILD		
								BUILDER			LAND DEVELOPER						
		North-east	Midwest	South	West	Builder	Land Developer	Small	Medium	Large	Less than 100 lots	100 lots or more	Yes	No	Currently building	Plan to build	No plans
Use low flow shower heads (max. 2-5 gallons per minute																	
Yes	87%	87%	87%	90%	83%	89%	78%	89%	89%	95%	74%	79%	89%	86%	88%	86%	87%
No	13	13	13	10	17	11	22	11	11	5	26	21	11	14	12	14	13
Respondents	404	47	118	147	86	327	73	218	53	42	34	29	54	339	52	35	293
Use water efficient landscaping																	
Yes	52%	44%	47%	53%	60%	51%	53%	52%	50%	59%	38%	66%	66%	48%	84%	58%	44%
No	48	56	53	47	40	49	47	48	50	41	62	34	34	52	16	42	56
Respondents	357	39	98	133	82	284	70	184	48	39	29	32	50	299	45	31	259
Other																	
Yes	44%	60%	36%	43%	36%	47%	27%	52%	-	50%	25%	100%	50%	44%	40%	100%	41%
No	56	40	64	57	64	53	73	48	100%	50	75	-	50	56	60	-	59
Respondents	57	10	14	21	11	45	11	31	2	10	8	1	14	41	10	3	41

Q9. METHODS AND MATERIALS USED FOR BUILDING GREEN - LAND DEVELOPMENT AND SITE DESIGN
(PERCENT OF RESPONDENTS)

	Total	FOUR CENSUS REGIONS				PRINCIPAL OPERATION OF THE FIRM		SIZE OF THE FIRM					TAKE ACTION TO RESPOND TO ENVIRONMENTAL CONCERNS		BUILD SUSTAINABLE DEVELOPMENT OR PLAN TO BUILD		
								BUILDER			LAND DEVELOPER						
		North-east	Midwest	South	West	Builder	Land Developer	Small	Medium	Large	Less than 100 lots	100 lots or more	Yes	No	Currently building	Plan to build	No plans
Site selection process considered environmental factors, natural hazards or sensitive features such as flood plains, steep slopes, endangered species habitat, wetlands																	
Yes	84%	93%	80%	83%	85%	79%	94%	76%	84%	89%	93%	96%	89%	82%	94%	92%	81%
No	16	8	20	17	15	21	6	24	16	11	7	4	11	18	6	8	19
Respondents	394	40	108	148	93	272	119	174	50	37	58	48	65	317	50	38	274
Retain/replace native vegetation																	
Yes	74%	73%	74%	75%	75%	70%	87%	70%	69%	64%	88%	89%	92%	70%	90%	86%	68%
No	26	27	26	25	25	30	13	30	31	36	13	11	8	30	10	14	32
Respondents	399	45	107	151	92	282	115	181	49	39	56	46	63	324	51	36	276
Minimized disruption to existing vegetation																	
Yes	86%	95%	88%	87%	77%	84%	91%	87%	82%	72%	91%	91%	95%	85%	90%	92%	84%
No	14	5	12	13	23	16	9	13	18	28	9	9	5	15	10	8	16
Respondents	409	44	115	153	92	290	116	188	51	36	57	45	66	330	50	39	281
Preserved visual corridors to reduce impact of development																	
Yes	73%	73%	75%	72%	73%	68%	86%	71%	65%	61%	88%	85%	89%	70%	84%	87%	68%
No	27	28	25	28	27	32	14	29	35	39	12	15	11	30	16	13	32
Respondents	379	40	100	144	90	267	109	173	48	36	51	47	62	305	45	38	263

Q9. METHODS AND MATERIALS USED FOR BUILDING GREEN - LAND DEVELOPMENT AND SITE DESIGN
(PERCENT OF RESPONDENTS) - (CONT.)

	Total	FOUR CENSUS REGIONS				PRINCIPAL OPERATION OF THE FIRM		SIZE OF THE FIRM					TAKE ACTION TO RESPOND TO ENVIRONMENTAL CONCERNS		BUILD SUSTAINABLE DEVELOPMENT OR PLAN TO BUILD		
								BUILDER			LAND DEVELOPER						
		North-east	Midwest	South	West	Builder	Land Developer	Small	Medium	Large	Less than 100 lots	100 lots or more	Yes	No	Currently building	Plan to build	No plans
Provided for zero net increase in storm water discharge from the site																	
Yes	65%	88%	67%	56%	66%	57%	81%	53%	65%	70%	81%	80%	60%	66%	74%	72%	59%
No	35	12	33	44	34	43	19	47	35	30	19	20	40	34	26	28	41
Respondents	386	42	102	144	93	270	113	171	49	37	54	45	65	312	47	36	267
Incorporate micro climatic variables into development																	
Yes	12%	6%	13%	13%	13%	10%	17%	8%	9%	14%	16%	18%	21%	11%	36%	29%	6%
No	88	94	87	87	87	90	83	92	91	86	84	82	79	89	64	71	94
Respondents	320	35	86	119	76	231	86	144	43	35	43	33	48	263	36	31	229
Provided access to mass transit																	
Yes	15%	14%	15%	10%	22%	13%	21%	9%	23%	9%	17%	24%	20%	13%	40%	14%	10%
No	85	86	85	90	78	87	79	91	77	91	83	76	80	87	60	86	90
Respondents	324	36	89	116	79	236	86	151	44	32	41	34	46	269	35	29	235
Reduce vehicle trip demand and trip distance by mixing land uses and providing a well-connected street network																	
Yes	33%	28%	34%	31%	39%	27%	51%	22%	29%	41%	44%	58%	50%	30%	59%	50%	27%
No	67	72	66	69	61	73	49	78	71	59	56	42	50	70	41	50	73
Respondents	326	36	88	119	79	234	90	148	42	34	43	36	48	269	37	32	236

Q9. METHODS AND MATERIALS USED FOR BUILDING GREEN - LAND DEVELOPMENT AND SITE DESIGN (PERCENT OF RESPONDENTS) - (CONT.)

	Total	FOUR CENSUS REGIONS				PRINCIPAL OPERATION OF THE FIRM		SIZE OF THE FIRM					TAKE ACTION TO RESPOND TO ENVIRONMENTAL CONCERNS		BUILD SUSTAINABLE DEVELOPMENT OR PLAN TO BUILD		
								BUILDER			LAND DEVELOPER						
		North-east	Midwest	South	West	Builder	Land Developer	Small	Medium	Large	Less than 100 lots	100 lots or more	Yes	No	Currently building	Plan to build	No plans
Considered solar orientation in site design																	
Yes	36%	38%	38%	30%	43%	38%	34%	46%	20%	20%	30%	37%	40%	36%	67%	56%	29%
No	64	62	62	70	57	63	66	54	80	80	70	63	60	64	33	44	71
Respondents	340	39	90	118	88	248	88	157	45	35	43	35	50	280	39	32	242
Other																	
Yes	19%	-	13%	22%	25%	16%	25%	9%	33%	33%	33%	-	20%	17%	25%	100%	8%
No	81	100%	87	78	75	84	75	91	67	67	67	100%	80	83	75	-	92
Respondents	36	3	15	9	8	31	4	23	3	3	3	1	5	30	4	1	26

Q10. AMOUNT SPENT PER DWELLING UNIT FOR SCRAP AND WASTE REMOVAL AND DISPOSAL (PERCENT OF RESPONDENTS)

	Total	FOUR CENSUS REGIONS				PRINCIPAL OPERATION OF THE FIRM		SIZE OF THE FIRM					TAKE ACTION TO RESPOND TO ENVIRONMENTAL CONCERNS		BUILD SUSTAINABLE DEVELOPMENT OR PLAN TO BUILD		
								BUILDER			LAND DEVELOPER						
		North-east	Midwest	South	West	Builder	Land Developer	Small	Medium	Large	Less than 100 lots	100 lots or more	Yes	No	Currently building	Plan to build	No plans
Less than $250	16%	16%	11%	12%	30%	13%	26%	13%	13%	7%	30%	16%	20%	15%	15%	18%	15%
$250 to $499	29	18	37	26	28	27	37	25	32	37	37	38	26	30	25	44	28
$500 to $749	24	30	25	21	25	27	13	26	21	37	7	19	23	23	23	15	26
$750 to $1,000	17	16	17	22	10	18	14	19	18	14	16	13	20	17	19	15	17
More than $1,000	14	20	10	19	7	15	10	17	16	5	9	16	11	15	17	8	14
Average	1,347	805	850	1,818	1,561	1,254	1,831	1,470	755	670	526	3,736	1,161	1,405	1,246	706	1,487
Median	600	730	600	750	500	700	400	700	600	538	400	400	600	600	600	500	600
Respondents	440	50	134	161	88	348	87	232	56	43	43	32	61	365	52	39	321

Q11. WASTE REMOVAL AND DISPOSAL PROCESSES TYPICALLY USED (PERCENT OF RESPONDENTS)

	Total	FOUR CENSUS REGIONS				PRINCIPAL OPERATION OF THE FIRM		SIZE OF THE FIRM					TAKE ACTION TO RESPOND TO ENVIRONMENTAL CONCERNS		BUILD SUSTAINABLE DEVELOPMENT OR PLAN TO BUILD		
								BUILDER			LAND DEVELOPER						
		North-east	Midwest	South	West	Builder	Land Developer	Small	Medium	Large	Less than 100 lots	100 lots or more	Yes	No	Currently building	Plan to build	No plans
Contract with waste hauler to provide an on-site dumpster for all waste	56%	79%	62%	49%	49%	55%	62%	53%	51%	70%	55%	72%	48%	57%	59%	63%	56%
Contract with waste hauler to provide waste removal withoutan on-site dumpster	22	8	16	33	18	24	13	23	35	27	7	17	19	23	18	15	24
Waste removal and disposal with your crews and equipment	34	31	32	32	43	36	25	40	33	16	30	19	40	33	43	39	31
Subcontractors are responsible for waste removal	16	19	13	15	19	15	19	12	16	32	16	25	15	16	10	12	16
Respondents	445	48	135	162	94	348	93	232	55	44	44	36	62	370	51	41	322

Q12. MATERIALS SEPARATED AND RECLAIMED FROM WASTE STREAM (PERCENT OF RESPONDENTS)

	Total	FOUR CENSUS REGIONS				PRINCIPAL OPERATION OF THE FIRM		SIZE OF THE FIRM					TAKE ACTION TO RESPOND TO ENVIRONMENTAL CONCERNS		BUILD SUSTAINABLE DEVELOPMENT OR PLAN TO BUILD		
								BUILDER			LAND DEVELOPER						
		North-east	Midwest	South	West	Builder	Land Developer	Small	Medium	Large	Less than 100 lots	100 lots or more	Yes	No	Currently building	Plan to build	No plans
Cardboard	45%	56%	50%	28%	59%	47%	37%	46%	50%	47%	38%	25%	58%	43%	53%	36%	44%
Metals	34	52	42	27	26	36	24	40	31	11	27	25	55	31	49	48	29
Paint	23	15	25	24	24	22	28	20	34	26	31	25	37	21	37	28	20
Clean dimensional lumber	68	37	67	68	81	71	50	73	69	63	50	58	68	68	70	72	68
Gypsum	23	4	20	20	36	23	20	20	31	32	19	33	26	21	21	24	23
Treated lumber	32	22	32	38	27	33	26	38	19	21	31	33	39	31	30	60	29
Plastic	22	22	22	25	19	22	22	24	19	5	31	17	42	19	42	20	17
Other	12	22	13	12	9	11	17	11	9	11	12	25	16	12	9	20	12
Respondents	287	27	88	97	70	238	46	176	32	19	26	12	38	242	43	25	200

Q13. WAYS TO MITIGATE WETLAND PROBLEMS
(PERCENT OF RESPONDENTS)

	Total	FOUR CENSUS REGIONS				PRINCIPAL OPERATION OF THE FIRM		SIZE OF THE FIRM					TAKE ACTION TO RESPOND TO ENVIRONMENTAL CONCERNS		BUILD SUSTAINABLE DEVELOPMENT OR PLAN TO BUILD		
								BUILDER			LAND DEVELOPER						
		North-east	Midwest	South	West	Builder	Land Developer	Small	Medium	Large	Less than 100 lots	100 lots or more	Yes	No	Currently building	Plan to build	No plans
Avoid wetland.....	85%	74%	87%	89%	81%	87%	78%	87%	89%	93%	78%	79%	78%	86%	80%	67%	89%
Mitigation banking.....	11	9	11	14	7	9	15	6	9	21	9	23	11	11	20	17	9
On-site mitigation.....	33	45	25	33	37	23	57	15	30	48	48	67	52	29	35	44	29
Other.....	2	2	3	2	1	2	3	3	-	-	3	2	3	2	4	6	1
Respondents.....	393	47	112	148	81	277	113	177	46	42	58	43	63	315	51	36	271

Q14. FEELINGS ABOUT THE SYSTEM OF CONTROLS ON GROWTH AND RESIDENTIAL DEVELOPMENT IN THE AREA WHERE YOU BUILD
(PERCENT OF RESPONDENTS)

	Total	FOUR CENSUS REGIONS				PRINCIPAL OPERATION OF THE FIRM		SIZE OF THE FIRM					TAKE ACTION TO RESPOND TO ENVIRONMENTAL CONCERNS		BUILD SUSTAINABLE DEVELOPMENT OR PLAN TO BUILD		
								BUILDER			LAND DEVELOPER						
		North-east	Midwest	South	West	Builder	Land Developer	Small	Medium	Large	Less than 100 lots	100 lots or more	Yes	No	Currently building	Plan to build	No plans
Too restrictive.....	56%	80%	45%	54%	60%	51%	69%	44%	73%	66%	71%	71%	69%	53%	62%	58%	53%
Not sufficient.....	4	2	3	6	3	4	3	5	4	-	5	-	-	5	4	5	4
Just about right.....	32	12	39	36	27	36	21	41	16	32	18	24	27	34	30	33	34
Not sure.....	8	6	13	4	9	8	7	10	7	2	6	4	4	9	4	5	10
Respondents.....	470	49	132	176	106	343	122	227	56	44	62	45	71	384	53	43	333

Q15. ENVIRONMENTAL AMENITIES WHICH HOME BUYERS WANT IN A HOME (PERCENT OF RESPONDENTS)

	Total	FOUR CENSUS REGIONS				PRINCIPAL OPERATION OF THE FIRM		SIZE OF THE FIRM					TAKE ACTION TO RESPOND TO ENVIRONMENTAL CONCERNS		BUILD SUSTAINABLE DEVELOPMENT OR PLAN TO BUILD		
								BUILDER			LAND DEVELOPER						
		North-east	Midwest	South	West	Builder	Land Developer	Small	Medium	Large	Less than 100 lots	100 lots or more	Yes	No	Currently building	Plan to build	No plans
•Allergin-free, chemical-free building materials	20%	16%	18%	19%	26%	22%	12%	23%	15%	26%	12%	11%	23%	19%	42%	32%	14%
•Solar heating	6	-	8	3	12	7	5	9	2	-	5	8	6	6	10	8	5
•Recycling containers built-in	14	8	22	8	18	15	10	19	12	5	5	13	21	13	23	19	12
•Alternative products to wood	13	6	14	13	14	13	11	15	10	5	12	11	15	13	19	22	11
•Increased energy efficient appliances	63	65	64	62	64	66	54	67	56	67	55	50	71	61	75	78	60
•Water conserving appliances and plumbing	43	47	45	34	54	45	36	48	29	44	33	37	47	44	60	54	40
•Wooded lots	66	65	68	80	40	65	73	67	60	64	74	76	74	65	60	68	67
Lower density	52	49	45	57	59	52	58	50	62	49	69	53	55	52	58	54	53
•Building products that cause no environmental harm when extracted from earth	11	16	10	9	12	12	5	12	12	5	10	3	16	10	27	22	7
•Building products that cause no known negative health impact to occupants	41	43	44	34	53	45	30	43	48	46	33	21	39	42	71	43	37
•Radon resistant construction techniques/radon abatement	23	49	22	14	28	23	23	24	21	26	17	26	21	24	40	24	21
•Water conserving landscaping	18	8	11	18	34	18	19	18	12	26	17	21	24	17	42	16	14
•Open space	48	41	50	47	53	43	67	40	50	51	64	71	53	48	50	46	49
•Water filtering system	19	12	18	22	18	21	9	23	19	13	5	11	18	19	31	27	16
•Other	4	4	2	5	4	4	2	3	2	10	2	-	6	3	6	3	4
Respondents	427	49	130	152	90	332	91	226	52	39	42	38	62	354	52	37	310

Q16. OPINIONS APPLICABLE WHEN YOU DEVELOP LAND OR PURCHASE DEVELOPED LOTS (PERCENT OF RESPONDENTS)

	Total	FOUR CENSUS REGIONS				PRINCIPAL OPERATION OF THE FIRM		SIZE OF THE FIRM					TAKE ACTION TO RESPOND TO ENVIRONMENTAL CONCERNS		BUILD SUSTAINABLE DEVELOPMENT OR PLAN TO BUILD		
								BUILDER			LAND DEVELOPER						
		North-east	Midwest	South	West	Builder	Land Developer	Small	Medium	Large	Less than 100 lots	100 lots or more	Yes	No	Currently building	Plan to build	No plans
Preserve open space by building on smaller lots and/or cluster development in a single area.....	34%	33%	34%	27%	46%	27%	51%	20%	34%	58%	46%	62%	51%	29%	55%	50%	27%
Leave as many trees as possible.....	89	94	90	94	78	89	91	92	89	75	89	96	85	90	91	87	89
Plant more trees.....	53	33	57	60	45	50	60	49	51	60	56	68	63	51	64	68	49
Build more energy efficient homes and quip them with energysaving appliances.....	55	56	55	55	54	61	39	65	49	60	36	38	57	54	82	66	50
Make greater use of recycled materials when building a house.	16	15	18	13	23	19	10	20	9	23	10	6	19	15	41	29	11
Minimize site disruption.	67	77	69	67	62	68	66	73	64	55	72	64	75	66	82	87	63
Other.....	2	-	1	2	2	2	1	1	2	5	-	2	1	2	2	-	2
Respondents.....	452	48	134	173	91	324	124	215	53	40	61	47	67	370	56	38	323

Q17. BUILD OR PLANNING TO BUILD A SUSTAINABLE DEVELOPMENT (PERCENT OF RESPONDENTS)

	Total	FOUR CENSUS REGIONS				PRINCIPAL OPERATION OF THE FIRM		SIZE OF THE FIRM					TAKE ACTION TO RESPOND TO ENVIRONMENTAL CONCERNS		BUILD SUSTAINABLE DEVELOPMENT OR PLAN TO BUILD		
								BUILDER			LAND DEVELOPER						
		North-east	Midwest	South	West	Builder	Land Developer	Small	Medium	Large	Less than 100 lots	100 lots or more	Yes	No	Currently building	Plan to build	No plans
Currently building.....	13%	20%	8%	10%	19%	12%	14%	13%	7%	18%	13%	13%	20%	11%	100%	-	-
Plan to build.....	10	12	11	10	6	7	17	9	2	3	13	21	13	9	-	100%	-
No plans.....	77	68	81	79	74	80	69	78	91	80	74	67	67	80	-	-	100%
Respondents.....	448	50	133	165	93	337	106	225	54	40	53	39	64	369	57	44	347

Q18. CUSTOMERS EVER ASK ABOUT ENVIRONMENTAL FEATURES IN A HOME (PERCENT OF RESPONDENTS)

	Total	FOUR CENSUS REGIONS				PRINCIPAL OPERATION OF THE FIRM		SIZE OF THE FIRM					TAKE ACTION TO RESPOND TO ENVIRONMENTAL CONCERNS		BUILD SUSTAINABLE DEVELOPMENT OR PLAN TO BUILD		
								BUILDER			LAND DEVELOPER						
		North-east	Midwest	South	West	Builder	Land Developer	Small	Medium	Large	Less than 100 lots	100 lots or more	Yes	No	Currently building	Plan to build	No plans
Often	11%	2%	12%	11%	14%	12%	8%	15%	5%	7%	11%	6%	16%	10%	41%	11%	5%
Seldom	52	54	52	48	57	49	61	48	45	62	62	58	57	51	44	74	51
Never	38	44	36	41	29	39	31	37	50	31	27	36	26	39	15	16	45
Respondents	440	48	131	159	95	346	89	234	56	42	45	33	61	368	54	38	323

Q19. INTERESTED IN LEARNING MORE ABOUT THE COSTS OF PROVIDING ENVIRONMENTAL FEATURES
(PERCENT OF RESPONDENTS)

	Total	FOUR CENSUS REGIONS				PRINCIPAL OPERATION OF THE FIRM		SIZE OF THE FIRM					TAKE ACTION TO RESPOND TO ENVIRONMENTAL CONCERNS		BUILD SUSTAINABLE DEVELOPMENT OR PLAN TO BUILD		
								BUILDER			LAND DEVELOPER						
		North-east	Midwest	South	West	Builder	Land Developer	Small	Medium	Large	Less than 100 lots	100 lots or more	Yes	No	Currently building	Plan to build	No plans
Yes	44%	44%	42%	51%	37%	43%	50%	42%	46%	45%	46%	60%	53%	43%	63%	61%	39%
No	22	22	24	17	29	22	23	23	23	20	27	17	20	22	15	5	26
Maybe	33	34	34	32	34	35	28	35	32	34	27	24	27	35	21	34	35
Respondents	469	50	138	174	100	353	111	235	57	44	56	42	64	392	52	44	337

Q20. CONSIDER PARTICIPATING IN A SUBSTAINABLE BUILDING OR BEST MANAGEMENT PRACTICE BUILDING PROGRAM
(PERCENT OF RESPONDENTS)

	Total	FOUR CENSUS REGIONS				PRINCIPAL OPERATION OF THE FIRM		SIZE OF THE FIRM					TAKE ACTION TO RESPOND TO ENVIRONMENTAL CONCERNS		BUILD SUSTAINABLE DEVELOPMENT OR PLAN TO BUILD		
								BUILDER			LAND DEVELOPER						
		North-east	Midwest	South	West	Builder	Land Developer	Small	Medium	Large	Less than 100 lots	100 lots or more	Yes	No	Currently building	Plan to build	No plans
Yes	28%	20%	28%	32%	25%	27%	30%	28%	21%	30%	26%	41%	42%	25%	49%	45%	20%
No	33	32	37	26	37	34	29	35	32	23	32	21	23	34	15	10	39
Maybe	39	48	34	42	38	39	41	36	47	47	42	38	35	41	36	45	41
Respondents	461	50	134	168	102	351	105	234	57	43	53	39	65	385	53	42	334

Q21. LABELED AN ENVIRONEMENTAL BUILDER, WOULD THAT BE GOOD, BAD OR NO DIFFERENCE
(PERCENT OF RESPONDENTS)

	Total	FOUR CENSUS REGIONS				PRINCIPAL OPERATION OF THE FIRM		SIZE OF THE FIRM					TAKE ACTION TO RESPOND TO ENVIRONMENTAL CONCERNS		BUILD SUSTAINABLE DEVELOPMENT OR PLAN TO BUILD		
								BUILDER			LAND DEVELOPER						
		North-east	Midwest	South	West	Builder	Land Developer	Small	Medium	Large	Less than 100 lots	100 lots or more	Yes	No	Currently building	Plan to build	No plans
Yes	58%	60%	59%	57%	57%	56%	64%	57%	54%	57%	61%	73%	67%	56%	75%	68%	54%
No	1	2	1	-	1	1	1	1	-	2	-	2	-	1	4	-	-
Maybe	41	38	40	43	42	43	35	42	46	40	39	25	33	43	21	32	46
Respondents	469	50	139	169	104	350	114	233	56	42	56	44	70	387	56	41	338

Q22. MAJOR DRAWBACKS TO ENVIRONMENTAL BUILDING
(PERCENT OF RESPONDENTS)

	Total	FOUR CENSUS REGIONS				PRINCIPAL OPERATION OF THE FIRM		SIZE OF THE FIRM					TAKE ACTION TO RESPOND TO ENVIRONMENTAL CONCERNS		BUILD SUSTAINABLE DEVELOPMENT OR PLAN TO BUILD		
								BUILDER			LAND DEVELOPER						
		North-east	Midwest	South	West	Builder	Land Developer	Small	Medium	Large	Less than 100 lots	100 lots or more	Yes	No	Currently building	Plan to build	No plans
Not enough information about or availability of environemntal building products.....	38%	45%	40%	36%	36%	39%	36%	41%	36%	40%	38%	34%	34%	38%	47%	51%	35%
Too expensive, making builders less competitive in local market.....	59	57	59	61	57	60	56	58	69	62	53	58	49	60	60	56	60
Don't know techniques....	28	27	29	32	20	28	28	27	31	31	36	18	21	30	25	37	28
Consumers do not care....	33	47	23	39	27	35	25	33	42	33	19	29	25	34	31	20	34
Consumers not willing to pay any additional cost.....	78	80	75	82	74	79	76	78	75	93	79	74	73	79	75	78	79
Takes more time.....	20	22	21	19	20	20	20	21	18	24	19	21	24	19	29	20	20
Other.....	3	-	2	5	2	3	2	2	4	10	2	3	3	3	4	2	3
Respondents.....	458	51	132	168	100	347	106	232	55	42	53	38	67	378	55	41	330

Q23. INTERESTED IN ATTENDING A SEMINAR TO LEARN TECHNIQUES FOR MARKETING THE ENVIRONMENTAL FEATURES OF HOMES
(PERCENT OF RESPONDENTS)

	Total	FOUR CENSUS REGIONS				PRINCIPAL OPERATION OF THE FIRM		SIZE OF THE FIRM					TAKE ACTION TO RESPOND TO ENVIRONMENTAL CONCERNS		BUILD SUSTAINABLE DEVELOPMENT OR PLAN TO BUILD		
								BUILDER			LAND DEVELOPER						
		North-east	Midwest	South	West	Builder	Land Developer	Small	Medium	Large	Less than 100 lots	100 lots or more	Yes	No	Currently building	Plan to build	No plans
Yes	26%	13%	27%	30%	28%	25%	32%	27%	21%	27%	31%	38%	41%	24%	36%	44%	21%
No	28	29	29	26	29	27	31	27	30	18	29	31	24	29	24	14	30
Maybe	46	58	44	44	42	48	37	46	49	55	40	31	35	47	40	42	49
Respondents	468	52	138	169	102	355	108	235	57	44	55	39	66	390	55	43	335

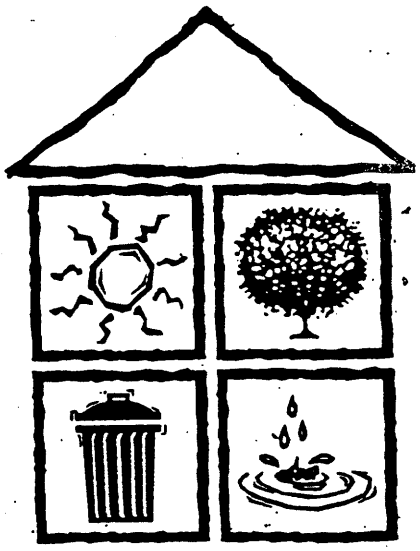
Q24. ANY INTEREST IN PARTICIPATING IN A VOLUNTARY ENVIRONMENTAL CERTIFICATION PROGRAM ?
(PERCENT OF RESPONDENTS)

	Total	FOUR CENSUS REGIONS				PRINCIPAL OPERATION OF THE FIRM		SIZE OF THE FIRM					TAKE ACTION TO RESPOND TO ENVIRONMENTAL CONCERNS		BUILD SUSTAINABLE DEVELOPMENT OR PLAN TO BUILD		
								BUILDER			LAND DEVELOPER						
		North-east	Midwest	South	West	Builder	Land Developer	Small	Medium	Large	Less than 100 lots	100 lots or more	Yes	No	Currently building	Plan to build	No plans
Very interested.....	10%	6%	9%	12%	13%	9%	14%	11%	4%	9%	11%	23%	19%	9%	24%	16%	8%
Somewhat interested.....	54	53	51	57	51	54	51	53	59	55	52	53	54	53	49	74	51
Not interested.....	36	42	39	31	36	36	35	35	38	36	38	23	26	37	27	9	40
Respondents.....	469	53	138	169	102	351	113	232	56	44	56	43	68	390	55	43	336

Appendix C: Austin Green Builder Program Brochure

Residential

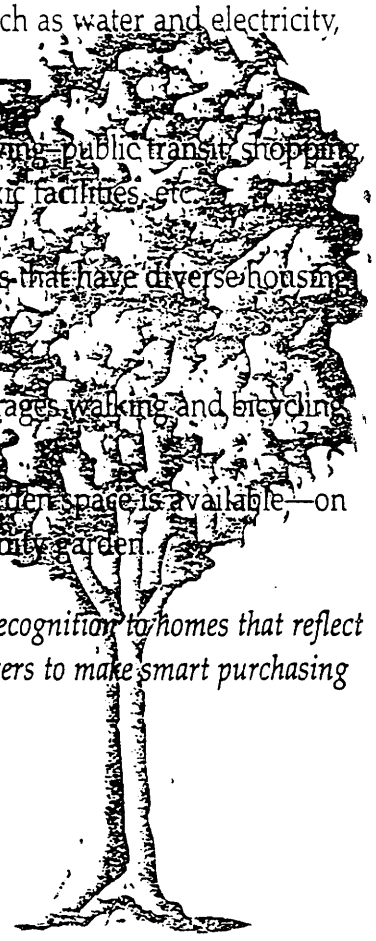
Green Builder Program



A Sustainable Approach

Green building encourages sustainable communities for a healthier planet

1. Remodel existing structures instead of building new ones.
2. Reduce building size with smarter design.
3. Build homes in town or in areas that already have an infrastructure of services, such as water and electricity, to reduce sprawl.
4. Locate homes for convenient living—public transit, shopping, schools, workplaces, parks, civic facilities, etc.
5. Locate homes in areas that have diverse housing types and prices.
6. Select a location that encourages walking and bicycling.
7. Plan homes in areas where garden space is available,—on the site or in a nearby community garden.



*The **Green Builder Program** gives recognition to homes that reflect these principles to encourage homebuyers to make smart purchasing decisions. Get With the Program!*

The Program

The Green Builder Program is the nation's first environmental building rating system. It was one of twelve winners, the only one in the United States, of the United Nations Local Government Initiatives Honors Program at the Earth Summit in Rio de Janeiro.

A Sustainable Approach

The Green Builder Program goal is to influence building practices to become sustainable:

- **Conserve energy, water and other natural resources.**
- **Preserve the health of our environment.**
- **Strengthen our local economy.**
- **Promote a high quality of life for the citizens of Austin.**

Sustainability

"Sustainability" means meeting our present needs without compromising the ability of future generations to meet their needs.

It means that the actions we take to provide for food, shelter, clothing, and other basic needs, must not jeopardize the natural systems that support all life. Understanding the nature of the interdependence of the human and natural environment is paramount to understanding sustainability.

It is common to look at one part of a home without considering its relationship to other parts—for example, how heating relates to the window size or to the direction the windows face. The fact is, every major part of a house has some influence on every other part of the house. The Green Builder Program looks at the house as a system that includes four main areas:

Water, Energy, Materials, Waste

The Green Builder Program addresses a small piece of a very large picture, yet it gives us a chance to promote the idea that nothing we do happens in isolation. Connecting building to the local, regional, and global environment allows other elements of sustainable community building (for example, where we build, how large we build) to fall into place.

Participation

How the Program Works

The Green Builder Program offers a rating of green homes on a scale of one to four stars— the more stars, the more green features and systems found in the home.

Building professionals such as builders, architects, engineers, trades persons, and suppliers receive technical guidance, as well as marketing assistance, in exchange for agreeing to offer and promote green building practices.

Potential homebuyers are assisted in learning about the value and availability of green homes, and are referred to Green Builder Program members.

The Homebuyer's Option

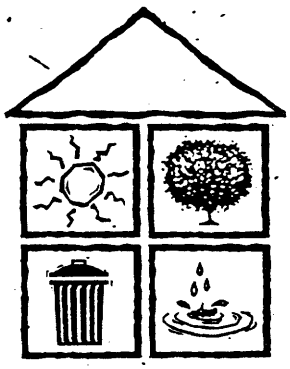
Look for the builders that are participating in the Green Builder Program.

Ask to see the items recommended in the Green Builder Program in the areas of energy, water, building materials, solid waste, and impacts on the community.

Look at the "Big Picture" when making choices for your home.

Ask questions. If your builder doesn't have the answer or you have specific questions about the Green Builder Program, contact a Green Builder Customer Service Representative at (512) 499-7827. Or write to:

The Green Builder Program,
Planning, Environmental and Conservation Services Department
206 E. 9th Street, Suite 17.102
Austin, Texas 78701



A Sustainable Approach

Green Builder Prog

One Star	Two Star
Water	
• Plant buffalo or common bermuda grass for any lawn installed in sunny areas	• All One-Star requirements plus: • Xeriscape for at least 75% of maintained landscape
Energy	
• 2 ceiling fans • At least 30 Energy Star points (see list*) • 12.0 Seasonal Energy Efficiency Rating (SEER) minimum efficiency rating of cooling equipment • Home design and specifications allow a minimum of 600 sq.ft. of living space per ton of cooling by Manual J calculation • Correctly designed and installed ducts sealed according to Mechanical Air Distribution and Interactive Relationships (MAD AIR) specifications*	• All One-Star requirements plus: • A third ceiling fan • At least 20 more Energy Star points (total of 50) • Roof radiant barrier • Continuous soffit venting plus ridge vent or other passive venting near the ridge; baffles to ensure air path is unobstructed by insulation • Water heater has a minimum 0.60 Energy Factor • East and west walls shaded by trees, arbors, trellises, etc.
Materials	
• 1 recycled-content material * • 2 engineered materials * • Concrete contains minimum 15% fly ash as a substitute for portland cement • No ozone-depleting insulation or sheathing (no chlorofluorocarbons or hydrofluorocarbons foam products*) • Low - volatile organic compound (VOC) paints and finishes to reduce outgassing of unhealthy fumes	• All One-Star requirements plus: • A second recycled-content material • Cabinets sealed inside and out with water-based sealer; or cabinets made out of solid wood, metal, or other non outgassing material
Solid Waste	
• Recycling center in or near kitchen, or a holding area in the garage or utility room	• All One-Star requirements plus: • Composting system for kitchen and yard wastes made at the site or off-the-shelf

ram - Star Ratings

Three Star	Four Star
• All Two-Star requirements plus: • A "water budget" estimate of indoor and outdoor water use (see Sourcebook*)	• All Three-Star requirements plus: • Rainwater from the roof to irrigate the landscape
• All Two-Star requirements plus: • Ceiling fans in all main rooms • At least 20 more Energy Star points (total of 70) • Minimum of 800 sq. ft. per ton of cooling (or install minimum 14.0 SEER) • Solar energy (passive or active) for one of the following: 40% hot water or 10% electricity or 15% space heat (earth-sheltering may substitute)* • Health risks from electro-magnetic fields reduced (see Sourcebook*)	• All Three-Star requirements plus: • At least 10 more Energy Star points. (total of 80) • Minimum of 1000 sq. ft. per ton of cooling (or install minimum 16.0 SEER) • Water heater provides space heat ("combo" system); minimum 0.60 Energy Factor and 80% recovery efficiency
• All Two-Star requirements plus: • A third recycled-content material • A third engineered material • One regional material • Any dimensional lumber 2x8 or larger is from a certified sustainably-managed forest* • Low -VOC exterior finishes and paints • Water-based glues • No unlined fiberglass material is exposed to the airstream of the heating and cooling duct system	• All Three-Star requirements plus: • A fourth recycled-content material • A fourth engineered material • Non-toxic termite protection ("Integrated Pest Management"*)
• All Two-Star requirements plus: • Trees cut at the site used for mulch, fenceposts, etc. (not landfilled)	• All Three-Star requirements plus: • Plan for the reduction and reuse of construction waste written and followed • Ventilated, lockable cabinet for storage of hazardous home products such as paint and pesticides

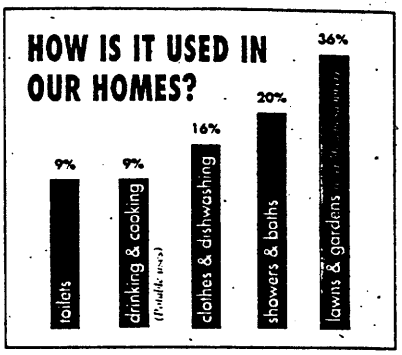
Water

Where does our water come from?

The City of Austin gets its water from the Colorado River at Town Lake and Lake Austin. The City has "free" water rights from the State of Texas up to a total of almost 49 billion gallons of water per year.

How does it get to us?

Water is pumped from the river at three water treatment plants that have a combined rated capacity of 225 million gallons per day. The water is clarified, chlorinated, and pumped through a distribution network of 2,700 miles.

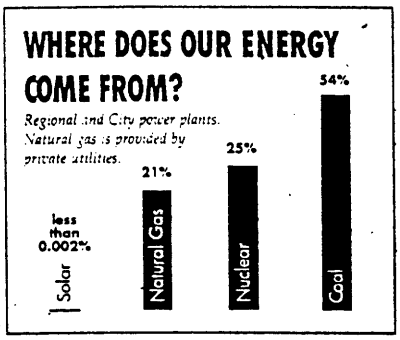


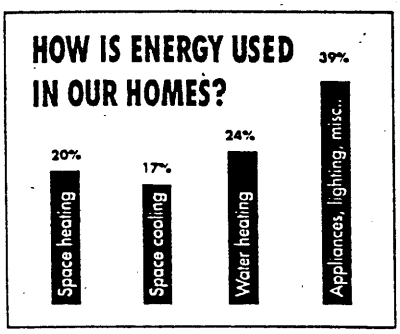
Where does used water go?

Three wastewater treatment plants remove biological contaminants, separate the sludge, and return the treated water to the Colorado River.

Sludge is composted with leaves and tree trimmings. The final product is called 'Dillo Dirt and is sold by nurseries as a soil-enhancement for ornamental plants and lawns.

Energy





Energy Fa

- Austin is located in the subtropical region of Texas, with hot summers and dry winters. The average annual temperature is 67.5 degrees Fahrenheit.
- Austin averages almost 60% sunshine during the year, with the lowest amount (49%) in January and the highest (68%) in August.
- An average all-electric home in Austin uses 18,83 kilowatt hours of electricity per year. This releases 266 pounds of sulphur dioxide, 99 pounds of nitrogen oxide, nine pounds of particulates and 10.5 tons of carbon dioxide into the atmosphere.
- A temperature difference of 16 degrees can exist between shaded and unshaded sides of a building. This translates to a 60% increase in the insulating effect of the shaded area—a significant benefit in cooling the house.
- An average full-size deciduous tree evaporates about 100 gallons of water per day. This creates a cooling effect outside the home equal to four tons of air conditioning.

Water Facts

- Austin uses an average of 108 million gallons of treated water each day in the spring, winter, and fall and 134 million gallons per day in the summer. Total water pumpage for Austin in 1996 was over 40 billion gallons.
- For outdoor and indoor use combined, the average Austin single-family household (2.7 persons) uses 120,000 gallons of water per year. The same household in a newer home, built to meet the current plumbing code, uses about 100,000 gallons per year. A Green Builder home could reduce this to 36,000 gallons per year.
- Austin's average yearly rainfall is 32 inches. A home with 2000 square feet of roof area could capture more than 31,000 gallons of rainwater annually—almost enough to meet the needs of a superior Green Builder home!
- Five billion gallons of water are flushed down the toilet each day in the U.S. We could save 3.5 billion gallons a day if all toilets met current code.
- The energy used by pumps makes the Water and Wastewater System the largest consumer of electricity in the City of Austin.

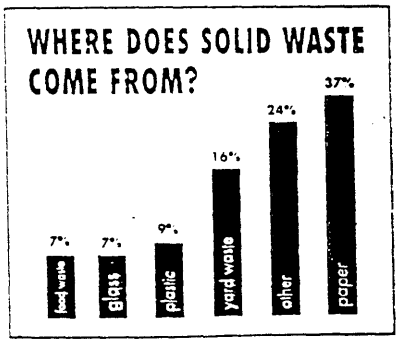
SEVEN BUILDING PRINCIPLES TO CONSERVE WATER

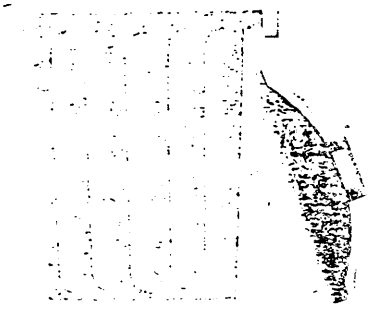
1. **Install plumbing fixtures and appliances that conserve water.**
2. **Plant a water efficient landscape (Xeriscape).**
3. **If landscape watering is needed, use an efficient irrigation system.**
4. **Collect rainwater for irrigation and other uses.**
5. **Recycle wastewater or greywater for irrigation and other uses.**
6. **Design the landscape to prevent water from running off the property.**
7. **Make a water budget to better understand the amount of water you use and how you use it.**

SEVEN BUILDING PRINCIPLES TO CONSERVE ENERGY

1. **Design your home to use local energy sources like solar, wind, and earth's thermal energy.**
2. **Design to get maximum benefit from both natural and artificial light.**
3. **Provide for a healthier indoor environment through effective ventilation and humidity reduction.**
4. **Save energy with a tight, well-insulated structure and duct system.**
5. **Install energy-efficient appliances, light fixtures, and heating and cooling equipment.**
6. **Use "waste" heat, such as waste heat from the air conditioner to heat water.**
7. **Plant a landscape that reduces heating and cooling needs.**

Solid Waste





Materials

What do we use?

Natural Resources

- Wood for structural material, cabinets, trim, siding, and numerous other uses
- Mined minerals such as copper and iron for piping, wiring, fasteners, roofing, and structural components
- Earth materials including clay for bricks, sand and gravel for concrete, sand for glass, and gypsum for dry-wall
- Hydrocarbons processed into a large assortment of plastics used in many building materials, and as important components of paints, adhesives, binders, sealers, and finishes

Recycled Resources

- Paper for insulation and sheet materials
- Cardboard for sub-flooring products
- Aluminum for roofing
- Steel for nails and framing members
- Wood fiber for wall blocks
- Plastic lumber
- Agricultural by-products for insulation and sheet materials

Where do Austin's building materials come from?

- Earth material products such as bricks, concrete and stone come mostly from regional sources.
- Ninety percent of the nation's plastics are processed in Texas.
- "White" wood lumber products come from out of state. East Texas is the primary source for Southern Yellow Pine, an extremely strong and widely used structural lumber. Some local species such as mesquite and pecan are harvested for flooring and furniture use.
- Metals and glass come from a variety of state, national, and international sources.

Where does building material waste go?

Most construction and demolition building material waste ends up in landfills. Very little reuse or recycling is currently practiced, in part due to low tipping (disposal) fees in the region.

How is solid waste handled?

Most solid waste goes to landfills. The operating landfills in Austin receive 600 tons of residential garbage each day. Additional solid waste comes from private haulers serving multi-family residences and businesses.

The Hazardous Household Chemical Collection Facility offers regularly scheduled times to receive hazardous household waste.

Approximately 24% of Austin's residential and commercial waste was being recycled in 1992. Residential recycling nearly doubled by 1995, and commercial recycling has also significantly increased.

Composted sewage sludge is made into a landscape fertilizer called 'Dillo Dirt.

Solid Waste Facts

- Americans generate roughly twice as much garbage per person as the Western Europeans or Japanese.
- Nationally, Americans throw away enough aluminum every three months (250 thousand tons) to rebuild our entire commercial air fleet.
- Each U. S. citizen generates an average of 6.2 pounds of waste per day.
- Recycling cuts energy consumption and pollution. Paper recycling can reduce air pollutants by 75% and water pollution by 67%; using scrap steel and iron rather than ore results in an 86% reduction in water pollution. Recycling aluminum saves 95% of the energy used to produce it from ore.
- A ton of recycled paper saves 17 trees and three cubic yards of landfill space.

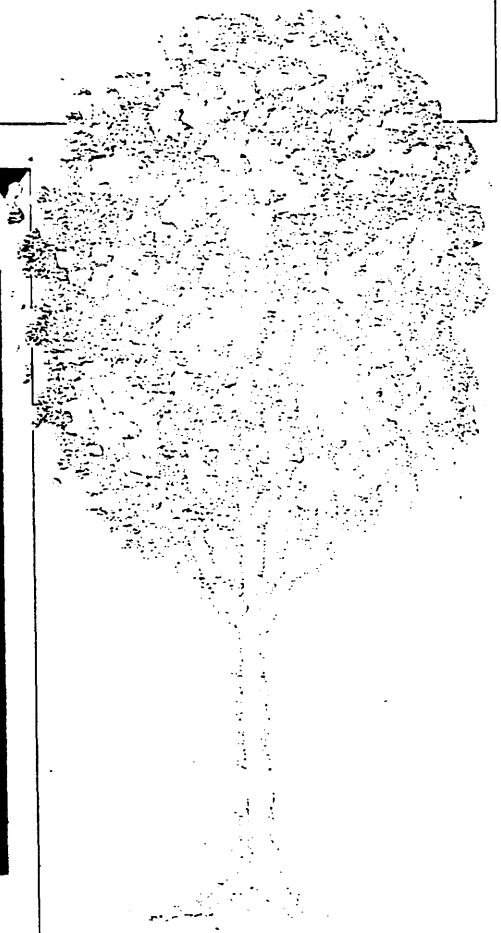
Building Material Facts

- A typical 1700 sq. ft. wood frame home requires the equivalent of clear cutting one acre of forest.
- Construction waste consists mainly of lumber and manufactured wood products (35%), drywall (15%), and masonry material (12%). The remainder is a mix of roofing materials, metals, plaster, plastics, textiles, glass, and, especially, cardboard packaging.
- New home construction consumes two-fifths of all the lumber and plywood used in the United States.
- U. S. citizens spend 80 to 90% of their time indoors where levels of potentially harmful organic chemicals in the indoor air may be much higher than the levels in outside air.

Note: Green building products and practices should meet all applicable safety standards and ordinances, and should be selectively evaluated for suitability to the project.

SEVEN BUILDING PRINCIPLES TO CONSERVE MATERIALS

1. **Buy lumber that comes from ecologically-managed forests.**
2. **Choose materials that require low amounts of energy to get from raw material to delivered product (low embodied energy).**
3. **Avoid materials that are toxic (during production and use) to people and the environment.**
4. **Select products that are engineered to save raw materials.**
5. **Choose products made of recycled and recyclable materials.**
6. **Use locally-produced materials.**
7. **Use durable materials.**



SEVEN BUILDING PRINCIPLES TO CONTROL SOLID WASTE

1. **Design for standard-sized materials to reduce waste.**
2. **Estimate material quantities accurately.**
3. **Choose products that avoid excessive packaging.**
4. **Construct a secure space, ventilated with outdoor air, for household hazardous materials**
5. **Build a recycling center in a convenient indoor location.**
6. **Provide a composting system for organic wastes.**
7. **Recycle construction and demolition waste.**

Light Framing Systems: Wood and Steel

Highlights and Summary Recommendations

The majority of houses and small commercial buildings in the United States are framed with wood, using studs, joists, and trusses or rafters. Because of concerns about overcutting of forests, unstable lumber costs, and poor lumber quality, light-gauge steel framing is gaining popularity among some architects and builders. Use of steel instead of wood raises other important environmental considerations, however. This report compares the environmental impacts of wood and light-gauge steel as framing materials for residential and small commercial buildings.

Highlights

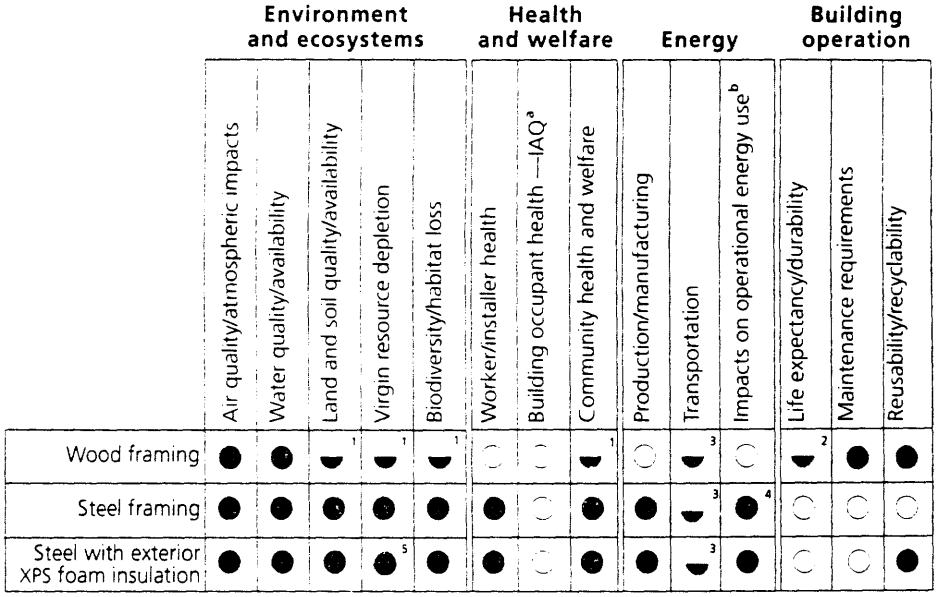
- The extremely high thermal conductivity of steel makes it a poor choice for framing insulated building envelopes unless measures are taken to counteract thermal bridging.
- The resource base for wood—forests and plantations—is quite variable in environmental performance. Well-managed forests can provide an extremely low-impact resource base, while poorly managed forests can be environmentally destructive. Forest management claims should be independently certified to be credible.
- Steel is energy intensive to produce, and some pollution from mining and manufacturing is inevitable. Wood framing is less energy intensive on a pound-per-pound basis, but it weighs more for a given structural application, partially offsetting the difference.
- Light-gauge steel framing typically contains 20 percent or more recycled steel. A few products contain as much as 95 percent recycled steel.
- Wood is renewable, though forests damaged through poor management may not be.
- Steel scrap is extremely easy to recycle and is collected at a very high rate. Wood is much more difficult to recycle.
- Untreated wood is biodegradable.
- Wood treated with toxic preservatives constitutes a significant solid-waste disposal problem as it is bulky, emits toxins when burned, and will not easily decay.

Summary Recommendations

- Use wood from certified, well-managed forests when it is available.
- Consider using steel when moisture or insects can compromise wood's durability or necessitate the use of toxic chemical preservatives.
- Consider specifying steel for interior framing and wood for exterior.
- Do not specify steel framing for the building envelope without taking measures to control thermal bridging.
- Consider alternative framing systems that might avoid the thermal bridging problem and make more efficient use of the material.

Comparative Environmental Performance
Light Framing Systems

Figure 1 Comparative Environmental Performance—Light Framing Systems*



Performance

- good
- varies from good to reasonably good
- reasonably good
- varies from reasonably good to poor
- varies from good to poor
- poor

Notes

General

Each cell in the above matrix is further explained in the "Environmental Impacts" figures in this report.

[a] Softwoods can be a problem for some chemically sensitive individuals

[b] Over time, environmental impacts from high energy use may far outweigh all other factors.

Performance Range

[1] This range is a function of forest management; higher performance applies when the lumber used comes from forests that are managed to maintain functions other than timber yield alone, such as ecosystem health.

[2] This range depends on proper detailing and building maintenance.

[3] "Transportation" ranges all depend on distance from the resource.

[4] This range depends on measures taken to counteract thermal bridging through steel framing members.

[5] This range depends on the particular product chosen: high value applies when recycled-content XPS is used.

*This chart represents an interpretation of environmental impacts identified in the material reports for a generic product group. Because manufacturing methods for proprietary products vary, the chart may not reflect the environmental performance of a given product.

Figure 2 Environmental Impacts of Wood Framing

Impact Group	*Impact Category*	*Environmental Impacts*
Environment and ecosystems	Air quality/atmospheric impacts	Deforestation eliminates an important "sink" of atmospheric CO_2, while well-managed forests help to maintain this sink.
	Water quality/availability	Clear-cutting on slopes and cutting too near waterways increase siltation of streams and rivers, damaging aquatic ecosystems.
	Land and soil quality/availability	Logging on steep slopes can cause severe erosion. Plantation forestry depletes soil and requires fertilizers.
	Virgin resource depletion	Excessive cutting in natural forests can harm the forest as a resource.
	Biodiversity/habitat loss	Well-managed, diverse forests can support biodiversity, while those managed solely for timber yield may eliminate large areas of habitat for many species. Plantations do not support biodiversity or provide wildlife habitat.
Health and welfare	Worker/installer health	Sawdust may be irritating. Contact with preservative-treated wood and breathing its sawdust may be hazardous.
	Building occupant health—IAQ	Volatile organics from aromatic wood species may affect chemically sensitive individuals. Trace toxins may escape from preservative-treated woods.
	Community health and welfare	Well-managed forests can support local forest-based industries indefinitely. Otherwise, depletion of the resource can have severe local and regional economic impacts.
Energy	Production/manufacturing	Relatively little energy is required for harvesting and for milling logs. Kiln drying uses the most energy, much of which comes from burning mill waste (hog fuel).
	Transportation	Usually by train and truck. Energy use depends on distance from wood supply.
	Impacts on operational energy use	Wood insulates better than most other structural materials and thus can be used to frame insulated walls, ceilings, and floors, with only minor energy penalties.
Building Operation	Life expectancy/durability	Wood can last for a long time as long as it is protected from extended contact with moisture and from harmful insects.
	Maintenance requirements	Wood framing must be kept dry and protected from harmful insects. Preservative treatments may be needed in some areas.
	Reusability/recyclability	Wood scraps from new construction and clean used wood are recyclable into particleboard or lower-value products, such as mulch. Lumber is sometimes salvaged for reuse.

Figure 3: Environmental Impacts—Light Gauge Steel
(Constituents: iron ore, limestone, coal, zinc, scrap steel, nickel, and other metals)

Impact Group	*Impact Category*	*Environmental Impacts*
Environment and ecosystems	Air quality/atmospheric impacts	Fuel combustion emissions from energy use at all stages. Similar air emissions, along with ammonia and dust, from coking ovens.
	Water quality/availability	Contaminated runoff from mine tailings delivers toxins to lakes and rivers. Significant water use to quench coal after coking, and to rinse steel during galvanizing and finishing.
	Land and soil quality/availability	Severe erosion and solid-waste problems at some mining sites for iron ore, limestone, and coal.
	Virgin resource depletion	Domestic supplies of steel's major constituents are all plentiful in United States. Nickel and certain other metals are largely imported. Light-gauge steel typically contains 20 to 25% scrap, about 14% of which is postconsumer. Steel from a small fraction of manufacturers can contain up to 95% recycled content.
	Biodiversity/habitat loss	Mining of iron ore, limestone, and coal causes severe environmental disruption, but to limited areas.
Health and welfare	Worker/installer health	Worker safety in steel making can be a concern.
	Building occupant health—IAQ	Steel framing does not offgas, so its impact on indoor air quality is negligible.
	Community health and welfare	
Energy	Production/manufacturing	Steel is relatively energy intensive to produce, requiring about 19,200 Btus per pound (44,660 kilojoules per kilogram) of product.
	Transportation	Usually by train and truck. Energy use depends on distance from raw material supply and from steel mill.
	Impacts on operational energy use	Used in the exterior walls, ceilings, or floors, steel framing members can compromise the thermal integrity of the building envelope.
Building operation	Life expectancy/durability	Very good if protected from corrosion.
	Maintenance requirements	Little or no maintenance required.
	Reusability/recyclability	Steel is easily separated magnetically and recycled into new steel. Overall, as much as 60% of the steel produced in the United States is recycled.

Figure 4: Environmental Impacts—Steel Fasteners
(Constituents: iron ore, limestone, coal, zinc, scrap steel, nickel, and other metals)

Impact Group	*Impact Category*	*Environmental Impacts*
Environment and ecosystems	Air quality/atmospheric impacts	Fuel combustion emissions from energy use at all stages. Similar air emissions, along with ammonia and dust, from coking ovens.
	Water quality/availability	Contaminated runoff from mine tailings delivers toxins to lakes and rivers. Significant water use to quench coal after coking, and to rinse steel during galvanizing and finishing.
	Land and soil quality/availability	Severe erosion and solid-waste problems at some mining sites for iron ore, limestone, and coal.
	Virgin resource depletion	Domestic supplies of steel's major constituents are all plentiful in United States. Nickel and certain other metals are largely imported. Steel fasteners often contain up to 95 percent recycled content.
	Biodiversity/habitat loss	Mining of iron ore, limestone, and coal causes severe environmental disruption, but to limited areas.
Health and welfare	Worker/installer health	Worker safety in steel making can be a concern.
	Building occupant health—IAQ	Negligible impact.
	Community health and welfare	
Energy	Production/manufacturing	Steel is relatively energy intensive to produce, requiring about 19,200 Btus per pound (44,660 kilojoules per kilogram) of product.
	Transportation	Usually by train and truck. Energy use depends on distance from raw material supply and from steel mill.
	Impacts on operational energy use	Minimal. Large fasteners extending through the building envelope can slightly compromise thermal integrity.
Building operation	Life expectancy/durability	Good except where subject to corrosive conditions.
	Maintenance requirements	Little or no maintenance required.
	Reusability/recyclability	Steel is easily separated magnetically and recycled into new steel. Fasteners must be collected separately to be recycled.

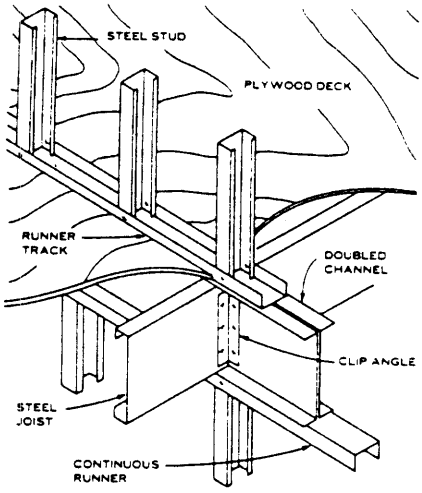


Figure 5: Interior Steel Stud Framing. (Reprinted by permission from *Architectural Graphic Standards*, page 262, 9th ed. Copyright 1994 by John Wiley & Sons, Inc.)

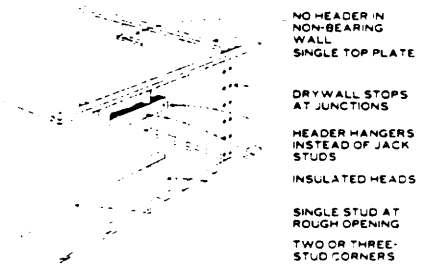


Figure 6: Reduced Use of Wood in Framing (Courtesy of NY-STAR, Inc. All rights reserved)

Recommendations for Architects

Below are some guidelines for choosing between wood and steel as framing systems and for reducing the environmental impact no matter which material is selected. Many of these recommendations are further explained in the life-cycle narratives that follow.

Choosing a Material

- Where wood is available from a certified well-managed forest, using it is not only less damaging but also may actually have a positive environmental impact. To ensure that the source is well managed, choose wood certified by an independent, third-party certifier recognized by the Forest Stewardship Council.
- Air-dried lumber has lower embodied energy than either steel or kiln-dried lumber. It should be specified if available with a suitably low moisture content.
- Consider specifying engineered wood members in place of large-dimension joists, rafters, or beams, which come from increasingly rare, old-growth trees.
- Consider specifying finger-joined lumber instead of solid studs, as finger-joined lumber uses the wood resource more efficiently—and usually performs better.
- Consider specifying steel for interior framing and wood for exterior framing. Using steel for interior walls avoids the thermal bridging problem, and thinner (~25 gauge) studs for non-load-bearing applications use less steel per member. They are also easier to work with than load-bearing 18- or 20-gauge steel (see figure 5).
- Where high moisture or wood-destroying insects are a problem, use steel or preservative-treated wood. The additional environmental burden of the preservative treatments usually makes steel environmentally preferable. Consider safer borate-treated wood where framing will be protected from the elements.
- Among exterior rigid insulation materials, rigid fiberglass and expanded polystyrene (EPS) are environmentally preferable to extruded polystyrene (XPS) or polyisocyanurate, because the former are not made with HCFCs, which deplete stratospheric ozone and are believed to contribute significantly to global warming.

Reducing Material Use

- Avoid "overbuilding" or using more wood than necessary. Framing at 24 inches (600 millimeters) on center saves wood and improves the thermal performance of the building envelope. Corners and rough-openings in walls are also frequently overbuilt (see figure 6).
- Steel-framed exterior walls should be constructed at no less than 24 inches on center. Some pre-engineered packages allow even wider spacing. With steel framing, fewer studs mean less steel, which saves resources and, more importantly, reduces thermal bridging.
- With either material, design ceiling heights and room widths to make optimal use of standard framing member dimensions, which are usually in 2-foot (600-millimeter) increments.
- Minimize long clear spans in floor and ceiling framing as these require much more structural material than shorter spans.

Using Materials Wisely

- Do not specify steel for exterior wall framing without taking measures to control thermal bridging. When comparing framing systems, consider the environmental impact of these measures, which may require additional materials (see figure 7).

- Steel structural systems need not follow the model of wood framing, with studs and joists every 16 or 24 inches (400 or 600 millimeters). Consider alternative framing systems that might avoid the thermal bridging problem and make more efficient use of the steel.
- Specify only low-cost, conventional cavity insulation when framing with steel. The advantage of thicker walls or higher-density insulation drops off quickly when the walls are being thermally short-circuited by steel studs. Create the minimum cavity you need for structural and utility purposes, and install insulation to fill the cavity (using full 24-in. batts, not the more common 22½-in. batts). Specify insulating sheathings to cover the steel studs with a complete layer of insulation.
- Don't fasten insulating sheathing directly to the studs with metal connectors. Screws or other fasteners will continue the thermal compromise of the stud, reducing the effectiveness of the insulation. Instead, specify that plywood or OSB sheathing or wood strapping be installed on the studs, and fasten the insulation to the panels or strapping.

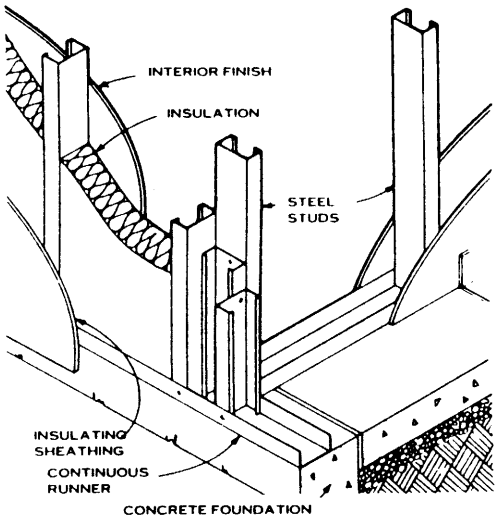
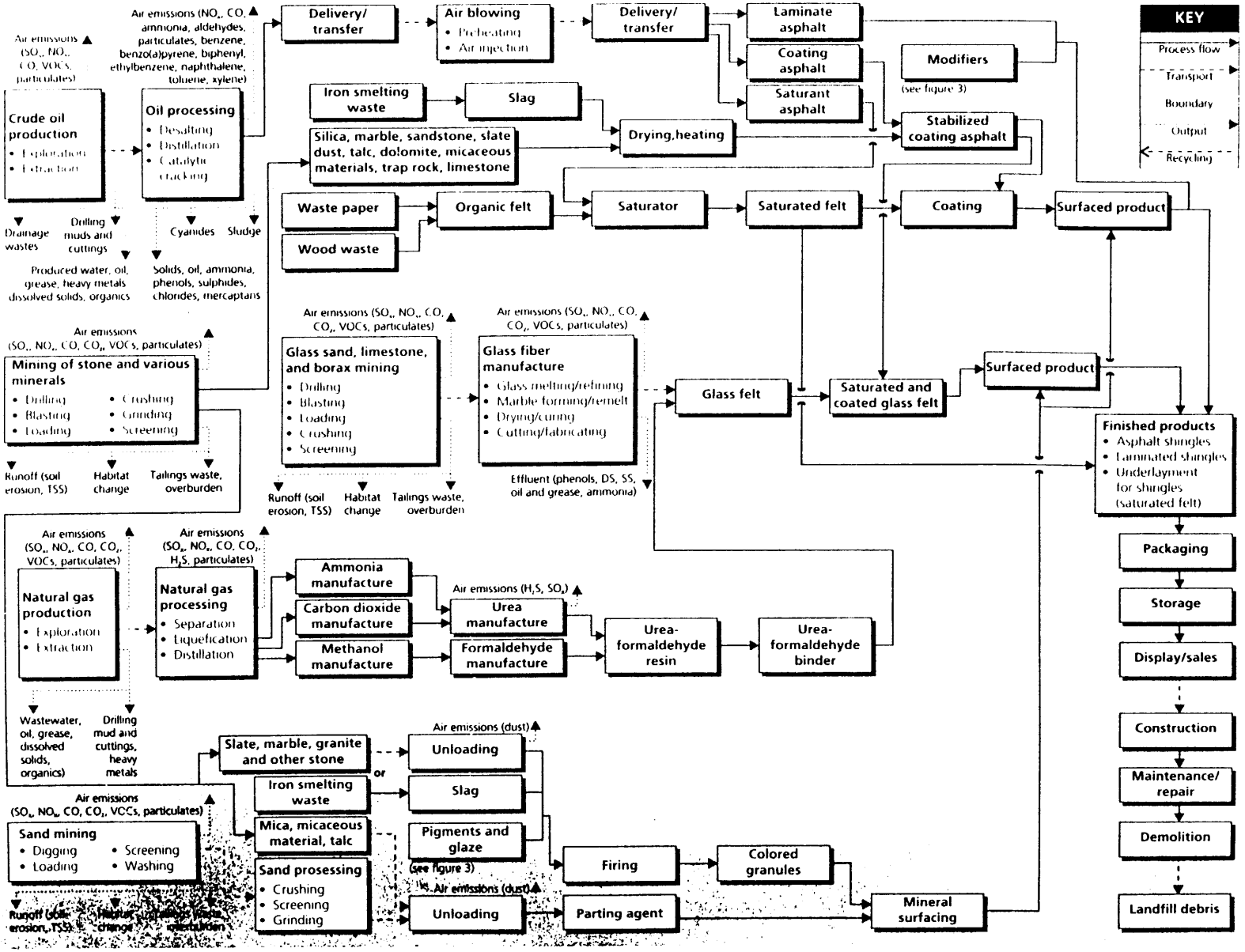


Figure 7: Exterior Steel Stud Framing
When using steel framing in exterior walls, add insulating sheathing to reduce thermal transfer. (Reprinted by permission from *Architectural Graphic Standards*, page 263, 9th ed. Copyright 1994 by John Wiley & Sons, Inc.)

Figure 1: Life Cycle of Asphalt Shingles



Appendix E: Common Indoor Air Pollutants

Indoor pollutants and toxins

Substance	Biological effects
GASES	
Ozone (O_3) Unstable, poisonous gas with penetrating odour; protects the earth from dangerous UV radiation. Also generated by photocopiers; exposure of polluted air to UV radiation; appliances with brush-type motors.	O_3 Decays rapidly into oxygen, but even small amounts are serious irritants to eyes, nose, throat, and respiratory tract.
Radon (Rn) Colourless, odourless, practically inert gas, present in certain geological areas. A serious contaminant which is carried into the home via dust, water, natural gas, and some building materials.	**Radon** inhalation damages lung tissues and long-term exposure is linked with cancer.
COMBUSTION GASES	
Carbon monoxide (CO) Colourless, odourless, poisonous gas from incomplete combustion in gas flames, wood, coal and tobacco smoke, vehicle exhausts.	CO reduces absorption levels of oxygen, causing headaches, dizziness, nausea and loss of appetite. Those with heart, lung, and circulation disorders are most susceptible.
Nitric oxide (NO) and Nitrogen dioxide (NO_2) Strong-smelling toxic gases from incomplete combustion of gas flames via cookers and boilers.	NO_2 is the most toxic of the nitrogen oxides, affecting the respiratory system.
Sulphur dioxide (SO_2) Pungent gas present in coal and wood smoke, and emitted by paraffin (kerosene) heaters. SO_2 was once responsible for urban smogs: now it produces acid rain.	SO_2 rarely occurs at dangerous levels but it can exacerbate breathing difficulties.
Carbon dioxide (CO_2) Colourless, odourless gas. A combustion product of bottled gas heaters. It is responsible for stale and stuffy air in poorly ventilated rooms.	CO_2 Continuous exposure may affect the central nervous system and slow down reactions.
VOLATILE ORGANIC COMPOUNDS (VOCs)	
Formaldehyde (HCHO) Binder and preservative with a pungent odour. At room temperatures, toxic vapours are released that contaminate the air. Widely used as a bonding agent and adhesive in timber and plastic products; a preservative in paper products, carpeting, furnishings; a finish for clothing and bed linen. Occurs in combustion byproducts from cooking and heating appliances, as well as in tobacco smoke. Urea-formaldehyde foam insulation (UFFI) foam used prior to mid 1970s is particularly hazardous.	**Formaldehyde** is a potent irritant to skin, eyes, nose, and throat with accompanying headache, dizziness, nausea, and breathing difficulties. It may cause nosebleeds. Suspected carcinogen. Chronic exposure to UFFI vapours causes depression and triggers chemical sensitivity.
Organochlorines Compounds of hydrocarbons and chlorine, which form the basis of many synthetic chemicals. Found in vaporous cleaners, air fresheners, polishes. Organochlorines are the most toxic and persistent of VOCs. They include **polychlorinated biphenyls (PCBs)**, known carcinogens; **polyvinyl chloride (PVC)**, a plastic that can offgas into stored food; **chloroform** and **chloramines**, both toxic gases. **Chloramines** are released when household bleach and ammonia-based cleaners are mixed together. Other hazardous VOCs include ammonia, turpentine, and acetone in cleaners and solvents; naphthalene in moth balls; chlorine in bleach.	Pungent vapours from **volatile organic compounds** are serious irritants to skin, eyes and lungs; they cause headaches and nausea and damage the central nervous system. All are potentially carcinogenic. **Organochlorine** vapours in solvents, pesticides, and cleaning fluids irritate skin, cause depression and headaches, and may damage liver and kidneys. **Chloramine** can be deadly.
Phenols or carbolic acids are caustic contaminants found in disinfectants, resins, plastics, and tobacco smoke. Phenolic synthetic resins in hard plastic, paints, coatings, and varnish contain formaldehyde. Never inhale **pentachlorophenol** found in wood preservatives and fungicides.	**Phenols** are corrosive to the skin and damage the respiratory system.
PARTICLES	
Asbestos Naturally occurring hazardous fibre mined from calcium magnesium silicate, used in insulation and fire-proofing. Banned in many countries.	Airborne **asbestos** fibres are a serious health risk causing asbestosis and cancers.
Microorganisms present in dust include disease-carrying bacteria and viruses, plus moulds, spores, and pollen.	**Microorganisms** spread infections and diseases. They also cause allergies.
Metals Trace elements from lead, cadmium, mercury, aluminium, and copper can be absorbed and accumulate to toxic levels in the body. Lead is present in old water pipes, exhaust fumes; lead and cadmium in paint; mercury in tinned tuna; aluminium is absorbed into food from cookware.	**Lead** and **cadmium** can damage brain and nerve tissues. **Cadmium** can also affect vision. Toxic levels of metals in the body give rise to headaches and breathing troubles.

Reprinted from The Natural House Book, David Pearson, Simon & Schuster.

Responding to pollutants

Source	Hazards	Action
Heating systems		
Paraffin (kerosene) and bottled gas heaters.	Carbon monoxide, nitrogen dioxide, carbon dioxide, sulphur dioxide. Condensation.	Do not use. If unavoidable, use for short periods only. Ventilate well.
Gas ranges, furnaces, and water heaters.	Carbon monoxide, nitrogen dioxide, carbon dioxide, sulphur dioxide. Leaks from pilot lights.	Vent all gas appliances to the outside. Replace with electrical models, or choose gas furnaces with sealed combustion chambers. Buy pilotless gas appliances. Have burners regularly serviced.
Oil furnaces.	Combustion byproducts; vapours from spillage.	Ventilate to the outside. Replace with electrical heating system, or seal boiler room from house.
Wood stoves and fireplaces; coal fires and furnaces.	Carbon monoxide, smoke, benzopyrene.	Have flues regularly swept and checked. Seal chimney cracks. Install air supply direct to fireplace.
Electricity		
Electrical wiring and appliances (TVs, VDUs, food processors, blenders, mixers, power tools, hair driers, photocopiers).	Low-level electromagnetic radiation. Ozone.	Use less electrical equipment and keep it away from sleeping spaces. Ensure protective wiring and devices are fitted.
Refrigerators.	CFCs released from coolant system.	New CFC-free models being developed. Meanwhile use a pantry.
Microwave ovens.	Radiation through ill-fitting doors.	Use other fast cooking methods (e.g. pressure cookers). Have ovens checked regularly.
Fluorescent lighting (old fitment).	PCBs from rapid start ballasts.	Replace old fitments. Use incandescent or halogen lamps instead.
Water supply		
	Lead and other heavy metals from pipes. Nitrates and other trace pollutants and chemicals. Bacteria and radon in showers.	Remove lead pipes and those with lead-soldered joints. Have water tested.
Air		
Air-conditioning and ventilation systems; humidifiers, heating ducts.	Airborne microorganisms, fungi, bacteria, moulds. CFCs released from some systems.	Maintain comfortable indoor humidity; ventilate to the outside. Have mechanical systems regularly checked.
Construction materials		
Earth, stone, granite, pumice; concrete, cement, fired bricks, aggregate blocks and tiles made from alum shale, calcium silicate slag, and uranium mine trailings.	Radium, radon. Concentration varies according to locality of source.	Contact local health and safety authorities for information on radon concentrations. Where necessary, seal cracks in building foundations. Increase ventilation to the outside.
Plaster, cement, and plasterboard made from phosphogypsum.	Formaldehyde. May contain high levels of radon.	Use natural gypsum plasterboard or lime plaster.
Asbestos, insulation, and fire-proofing materials around pipes, boilers, and tanks; roof and floor tiles and boards.	Minute mineral fibres; blue and brown asbestos is more dangerous than white.	Asbestos is now banned in many countries, but is still found in older houses. Do not disturb or remove flaking asbestos; seek expert advice.
Urea-formaldehyde foam insulation (UFFI) for cavity walls.	Formaldehyde.	Banned in the US. Have indoor air tested. If found, seek specialist advice.
Timber and timber products		
Pinewood, spruce, and other conifer wood.	Resin vapours.	Use older, recycled wood or other solid lumber. Seal with nontoxic finish.
Chipboard, fibreboard, hardboard, particle board, plywood: used in furniture, units, shelving, floor decking, and wall finishes.	Formaldehyde vapours from resin binder, especially when product is new, and in hot, humid climates.	Use solid lumber or "low-emission" formaldehyde boards Buy solid wood or rattan, bamboo, and wicker furniture.

Source	Hazards	Action
Timber treatments.	Lindane, pentachlorophenol (PCP), tributyl tin oxide (TBTO).	Avoid these toxic insecticides and fungicides.
Fabrics and fibres		
Synthetics (e.g. polypropylene and polyester used in carpeting, underlays, upholstery, bedding, clothes).	Formaldehyde vapours. Also insecticides, soft plastics, flame retardants, crease and stain repellants.	Avoid synthetic products, especially wall-to-wall carpeting. Use natural, untreated materials such as cotton, linen, wool, burlap. Wash before use.
Feathers, down, hair.	Allergies in sensitive people.	Use natural latex pillows, mattresses, and cushions. Protect with close-woven, natural cotton.
Paints, varnishes, stains, removers		
Used throughout the home on walls, floors, ceilings, woodwork, furniture.	Volatile organic compounds (VOCs). Toxic vapours and odours in drying: paint removers are the most toxic. Added fungicides and insecticides. Metals.	Avoid petrochemical paints: if you must use them, keep windows fully open and allow plenty of time for the paint to dry before reusing the room.
Adhesives		
Adhesives, glues, and mastics: used for wall and floor tiles, furniture assembly, weather sealing, wallpaper paste.	VOCs, notably formaldehyde. Toxic vapours during application and drying.	Use traditional nonchemical glues or water-based acrylics with low solvent content.
Metal products		
Cookware, paints, pipes, structural uses, furniture.	Leaching of trace elements into water – lead, cadmium, mercury, aluminium, iron, magnesium, copper. Lead and cadmium are ingredients of paints. Aluminium in cookware can leach into food. Metal furniture springs can distort electromagnetic fields.	Use natural paints Change to stainless steel, glass, or enamel cookware.
Plastics		
Foam filling in chairs, mattresses, cushions, and pillows.	Polyurethane: serious fire hazard.	Banned in UK and other countries. Use safe alternatives.
Vinyl plastics in floor and wall tiles, electrical equipment, imitation wood panelling, wallpapers.	Formaldehyde and other toxic vapours. Vinyl chloride.	Use natural alternatives.
Acrylics used in imitation glass sheets, wrappings.	Toxic vapours. Suspected carcinogens.	Avoid: even small amounts can be dangerous. Use safe alternatives.
Soft plastics (thermoplastics) used in numerous household products (e.g. food packaging and storage).	Vapours, especially in hot conditions. Food contaminants.	Use natural alternatives such as cellophane or greaseproof paper. Store food in glass, earthenware, or china containers.
Household maintenance		
Cleaners for ovens and carpets, polishes, bleaches, disinfectants, detergents, air fresheners, personal hygiene products.	Formaldehyde. Phenols, vinyl chloride, aldehydes, benzene, toluene, ketones, ammonia, chlorine, lye. All are highly irritant and toxic if swallowed. Aerosol sprays with CFCs.	Use natural alternatives and home remedies. If you must use chemical cleaners, wear gloves and protect skin from splashes. Store in a safe place away from children. Ventilate to the outside.
Pesticides and fungicides		
	Toxic – irritants and possible carcinogens.	Practise biological pest control.

Reprinted from The Natural House Book, David Pearson, Simon & Schuster.

Appendix F: Interview Notes and Survey Summaries

Interviews are listed in order by interviewee's last name.
Survey summaries follow.

Interviewee: David Adamson
Company: Eco-Products
Role: Owner

and

Interviewee: Christopher Prelitz
Company: Native Sol
Role: Owner / Builder

Interviewer: Maia Hansen
Date: November 1, 1997

Notes

Background:

- Eco-Products is a retailer of green building products in the Denver, CO area.
- Native Sol is a custom builder in Laguna Beach, CA which specializes in green building.

Trends in Construction and Green Building

- The leaders in green building are consumer focused and custom builders.
- A large builder in Denver (McStain) is active in developing green homes.
- Leading manufacturers are and will continue to be the large producers, such as Weyerhaeuser, Interface, Trus Joist McMillan.
- There is a strong overlap between green building and computer literate people
-

Distribution of Green Building Products

- There is a lack of money for marketing of green products in general.
- "Green building works well with the press - but not as well with consumers."
- Green products need to start by being smart and good quality and then sell the green features as extras.
- Good distribution models include cooperative private labeling, as in the ace hardware model.
- Eco-Products is moving toward a smaller group of core products - decking carpeting, other commercial materials, and site amenities. They are trying to improve efficiency and marketing and grow at a moderate rate over a long period.
- There needs to be more economies of scale to make green building distribution economical.
- The major barriers to green building include
    - resistance to innovation in construction
    - Lack of marketing
    - Lack of product knowledge
    - Fear of resale by consumers
    - Poor management in the small green companies

Needs

- Most green products that builders need already exist.
- Need more warranties: "People are unwilling to take the risks to use the new products."
- Wall systems are good, good roofing systems are lacking.
- Need financing or marketing incentives to build houses of higher quality. - real estate agents, mortgage companies, insurance agencies. Insurance companies are already active in addressing weather related risks from potential climate change. This awareness could make them more willing to look at elements in green housing.

Recommended Investments

- For profit:
    - Eco-development incorporating cluster development with environmental and health features
    - Marketing which bundles and packages green products
- Non profit: Education of all parties involved with construction

Interviewee: Art Castle
Company: Kitsap County Washington Home Builders Association
Role: Director

Interviewer: Maia Hansen
Date: November 12, 1997

Notes

Background:

- Unlike the Austin program, the Kitsap County Green Builder program is run by builders for builders, not by the city or another agency. It was developed as a market and information programs for local home builders. Manufacturers and others interested in building green can participate as partners.
- Currently 20 percent of local area builders have enrolled.
- Art came to the Kitsap HBA from another HBA. He was hired to address concerns about capacity constraints on a local landfill. They were "looking at a landfill closure in 5 to 10 years, with the closest alternative across a range of mountains." The increased transportation distance would increase tipping fees by up to three times. In 1994, the HBA submitted a grant proposal to the state to address this issue but were denied.
- In the end of 1995, they started developing the current Green Builder program and announced it officially at the February 1997 HBA annual dinner meeting.
- In the recent parade of homes, 4 of 40 were Green Builder homes.
- The program includes requirements for indoor air quality, water conservation, and energy efficiency. It also includes a mandatory job site recycling program and a distribution of a handbook to consumers.
- The Washington state energy codes are already fairly strict.
- The Two Star Level requires the following elements:
    - A total of 30 points are required out of eight areas.
    - Site treatment
    - Reduce / Reuse / Recycle
    - Purchasing resource efficient products
    - Energy efficiency beyond the state code
    - Improved indoor air quality
    - Managing Hazardous waste
    - Encouraging responsible home ownership through indigenous landscaping, compost bins, etc.
- A three star level goes beyond this
- They have received little feedback from consumers, but in general home buyers seem to be most interested in indoor air quality (by limiting carpets, changing ventilation, improving duct sealing, and adding exhaust fans) and energy efficiency (mostly with appliances).

Expected Trends in Construction and Green Building

- Growing consumer awareness
- Small builders are more likely to be involved in green programs than large in residential construction. Large builders are more reluctant to change and they don't perceive a consumer demand.

Barriers

- Lack of public / consumer education
- Little advertising
- Construction is slow to innovate

Interviewee: Dave Crosby
Company: Living Structures
Role: Builder and Project Manager

Interviewer: Maia Hansen
Date: November 1, 1997

Notes

Background:

- Living Structures does custom work in residential green building.

Expected Trends in Construction and Green Building

- Builders will use less wood. "We're just about out of good wood and we're not admitting it."
- "People are just realizing that what we think is traditional is not sustainable."
- "The modular approach to construction is our bane."
- Builders will use more locally available, indigenous materials
- Construction needs to be better incorporated into the industrial waste stream.
- Residential customers are easier to work with. Commercial builders are less interested in value and more interested in managing cash flow and bank notes.

Barriers to Green Building

- Most people expect a price premium from green building - but he doesn't believe there is one.
- There is a lack of information on green building products; it is not dependable and not widely disseminated.
- The products that builders need are available, but distribution and customer education are weak.
- "Green products need to fit it:" Green building products need work with four foot modules, because that fits the accepted building methods and makes the end product less expensive. "Contractors train crews to work a certain way."
- Training of construction trades. He spends a lot of time training contractors who do not know how to install systems and products, such as gray water systems, solar hot water heaters, etc.
- "It comes down to the guy in the field."
-

Interviewee: Dan Donihoo
Company: DuPont Tyvek
Role: Manufacturers representative in Austin, TX

Interviewer: Maia Hansen
Date: October 31, 1997

Notes

Background:

- DuPont producer Tyvek, a common house wrap product used to increase insulation and decrease vapor penetration in houses.
- Tyvek is positioned as an energy product which is proven in the market.
- "DuPont is a very conservative company which will not allow untested applications of its products."

Trends in Green Building

- Regional Growth: He has seen increasing demand for green products over the last five years. However, while the Austin area is very interested, "you can go 60 miles south and get no interest."
- Challenges for green manufacturers include:
    - a need for more consumer education
    - education of lending institutions
    - education of HUD and other government organizations
    - national programs to establish uniform programs, such as the national energy code and other building codes.

Interviewee: Ian Fultz
Company: Ener-Grid
Role: Texas Distributor

Interviewer: Maia Hansen
Date: November 1, 1997

Notes

Background:

- Ener-grid is a structural wall system made from blocks of recycled Styrofoam. The blocks are easy to work with and costs $5/SF for materials and labor and provides R-40 insulation qualities. It has a vapor barrier, but is also breathable. Elements are lightweight, do not rot, and withstand 200 miles/hour wind loads.

Expected Trends in Construction and Green Building

- Consumers are becoming more educated and demanding better value.
- Homeowners are less mobile and therefore more willing to make longer-term investments in their houses.
- He sees similarities between green building and the fledgling computer industry in the 1970's.
- The greatest barrier is the conservatism of architects and builders, who are "making a good living building with 2x4's. Why would they want to switch systems?"

Overcoming Barriers

- Training programs to improve skills with alternative building methods.
- Targeting the consumer - rather than just the builders and architects - through model homes and trade shows open to the public.
- Developing collateral products which fit within the new building system and provide features which are attractive to the consumer. For example, Ian has modified standard Ener-grid designs to allow for built in shelves, wine racks and other interior details.
- Improving the aesthetics of green building products so that they provide something that you can not get with traditional products. He says that stucco actually works better with his system than with 2x4's and is more cost effective. He has also used a line of breathable paints which works well with his product, but is difficult to apply to sheetrock. He may develop a private label of these paints to sell to other Ener-grid distributors.

Recommended Investment

- Build Ener-grid manufacturing plant.

Interviewee: Robert Habian
Company: EcoSmart Healthy Properties
Role: Senior Vice President

Interviewer: Maia Hansen
Date: November 1, 1997

Notes

Background:

- Robert's professional background is as an architect.
- A few years ago, he became a distributor for Ener-grid, but quickly found that market barriers were very high. As the distributor of one product, he did not have the money to educate the entire building industry.
- EcoSmart Healthy properties was developed by Barry Dimson and himself to "fill the gaping void" that exists in education of the public on environmental and health issues.

EcoSmart Healthy Properties

- EcoSmart Healthy Properties is a private, for-profit company that is trying to join the resources of many small green manufacturers together to promote green building, in general. Charges to manufacturers for display space will generate $2 million. With that money, they have negotiated a 10 year lease in New York for a design center that will be accessible for free by designers, students, bankers, and the public in general. The remainder of the revenue is used to educate the top ten developers in the United States on the benefits of building green.
- Market priorities include indoor air quality, smart buildings which include advanced telecommunications, recycled content materials, and more systematic building materials.
- Products will be sourced from the U.S. and Europe, primarily.
- The design center is expected to develop into additional services, including catalogues and building development. One current proposal is to convert an office building in Philadelphia into a healthy hotel.

Interviewee: John Kennedy
Bill Morash
Michael Skeldon
Company: Kennedy & Rossi

Interviewer: Maia Hansen
Date: November 4 1997

Notes

Background:

- Kennedy & Rossi is a construction manager / developer which specializes in commercial and institutional construction in the Boston area. They do no public or residential work.
- The interview was structured around details of four current projects which collectively represent a typical range of their work. These projects were as follows:
    1. Office conversion for Tufts Health Plan in a leased facility in Watertown, MA. Building began as a rough warehouse of approximately 500,000 SF. The contract is worth approximately $20 million dollars with an additional $10 million parking garage. Decisions are made jointly with the builder owner, the long term tenant (Tufts), the architect, and Kennedy & Rossi.
    2. An office and production facility renovation for the Genetics Institute - a biotechnology firm. Contract value is $2 million. The lease is only three years, and hence investments are minimal.
    3. Small renovation project for MIT. Typified as "ultra-long term" investors.
    4. Groton Preparatory School athletic center. Mostly new construction with some renovation. Contract value approximately $20 million. Decisions are made primarily by the architect with great input from the trustees and some from Kennedy & Rossi. The investment horizon is very long term and focuses primarily on aesthetics, not equipment.

Green Issues in General

- "The more picky tenants tend to be technically inclined and more likely to have a staff to work with facility issues." large = more sophisticated.
- "Schools wouldn't possibly think about this."
- "Commercial developers are most sensitive to costs, institutional clients least."
- 5-10 years trends:
    - "Indoor air quality has not hit a peak yet. It could be like asbestos, and be stuck at the mercy of legal risks. Owners are concerned about liability, such as in the Motor Vehicles building."
    - It is "hard to go to far from the main stream."
    - "Energy conservation is stagnant."
    - "Water is a limited resource and therefore could be important, but currently I'm not sure how much else you can do."
    - "The marketing opportunities with buildings like 4 Times Square are a good idea fundamentally - within reason."
- Preferred investments:
    - Indoor air quality - monitoring, control, products
    - Replacement for dimensional lumber and sheetrock - commodities that fluctuate in price.
    - Better designed systems. "Buildings are not designed like a car. They are done in pieces with no clear responsibility."

Indoor Air Quality

- "90 percent of clients ask about it."
- Clients are focused on the quantity of fresh air in the building and dehumidification.
- Chemical emissions of finishes and furniture is addressed by installing these items earlier so that they can off-gas more before building occupants more in and by turning on the air system earlier. Many clients have a third party industrial hygienist test and document the air quality before move-in to show to employees.
- Pharmaceutical companies and hospitals are mandated by FDA requirements to meet high levels of air exchange. In operating rooms and pharmaceutical production spaces, 100% air exchange is required. No recycling is allowed.
- "Schools follow the open window method of indoor air quality." Nevertheless, there is "always someone interested" in air quality.
- In the Groton athletic center, air handling was a major importance, particularly because the facility included an ice rink which required a Zambone. An electric powered (vice propane powered) Zambone was purchased to reduce fumes inside the building. In addition, the capacity of the mechanical equipment was increased by 25 percent.
- In the Tufts facility, the tenant requested that the air handling system be enlarged. Kennedy & Rossi suggested that a heat pump would be just as effective, and more energy efficient. Nevertheless, Tufts chose the air handling system, because of a perception that more CFM is better.
- Large architectural firms are developing a more keen eye with respect to liability. There staffs are now better able to handle IAQ issues.
- The largest product needs were
    - carpets, furniture, and partitions which had arrived with all or most of the VOC's dissipated.
    - more efficient heat exchange systems (the current ones get dirty quickly and take over three years to create a payback)
- Another desire was a true standard for fresh air.
- They had one client with a sick building. The solution was to change the air handling equipment and relocate the intake for outside air.
- Future trends are expected to be a focus on bigger air handling units - preferring air quality over energy conservation.
- "Indoor air quality problems are solved with equipment. Architects don't work with it. They just pass it off to engineers and architects who choose the equipment. To make things worse, the engineers think the equipment is better than it is."
- There was no sense of any new products on the market or of advances abroad. They did note that the European system for building design was more logical and therefore might result in better quality designs for ventilation.

Energy Conservation

- "90 percent of clients ask about it, but then only 10 percent decide to act on it."
- "There is an awareness, but no leap of faith."
- "The tenant pays the electric bills, but the building owner invests in the equipment."
- The engineer approach is to install lights with auto dimmers, and motors with variable frequencies.
- The utility approach (especially in this time of deregulation) is to back away from credits and look more at "realistic paybacks" such as dual feeds for electricity and gas.
- Owners are most worried about maintenance issues and long term livability
- Architects see diminishing returns to energy efficient features. They may look at specialty windows but then decide that the existing energy efficient windows are pretty well designed.
- Opportunities for improvement exist with fine tuning operations so that lights are isolated and only used where needed.
- Daylighting in design is popular, but more for appearance than for energy reasons. "The lighting consultant will probably still design the system for the cloudy day in January and the lights will stay on the rest of the time."

- Insulation and roofing are already well engineered. "They are now driven by code and no one is out trying to reinvent them."
- Alternative energy is not much in demand.
- There is a stigma with solar panels that they have poor aesthetics and are just a fad from the '60s or '70s.
- A former project with Children's Hospital used solar panels, but other than that they have had no discussions with clients about the relative merits of any alternative energy technologies.
- "There is little public relations on alternative energy."
- Geothermal systems had been used by two clients in the past - a retirement community far outside the city and the Union for Concerned Scientists in Harvard Square. The latter chose it, "despite a 10,000 year payback."
- Some clients have looked at cogeneration, but decided against it because it would be one more operations requirement outside of their core competency.

Material Reuse and Conservation

- Very few people ask about this - maybe 10 percent at most.
- Asphalt is recycled, as is wallboard on the home building side.
- Structural steel and copper are carefully segregated and then sold as scrap. (They use the proceeds to fund the annual Christmas party, etc.)
- The labor costs for sorting are higher than any revenues from saving other construction waste.
- There is no exchange of scrap materials between construction sites or other buyers and sellers.
- They can't imagine a wholesale reuse of wide flange sections - the handling expenses would be too expensive.
- They tried reusing brick once, but it was too difficult to match with new sections. They were persuaded to buy new brick, rather than paying the mason to do the matching.
- Tufts looked at buying ceiling tiles made of recycled material, but decided against it because they liked another style. The fact that it was made from recycled material wasn't that important.

Water Conservation

- In general, water conservation is most important to their pharmaceutical clients which use a lot of filtered water in their process and produce a lot of wastewater. Water treatment becomes one of their highest costs. "They buy water for much less than one cent per gallon and then treat it for five cents." The process is very well defined by the FDA, leaving little room from the engineering side."
- 1.8 gallon (low-flow) toilets are unpopular and clients complain about them. They have no complaints about low flow shower heads.
- Most clients assume water conservation techniques are mandated.
- Commercial kitchens, despite using a lot of water, are not very concerned with water conservation.
- Landscape irrigation at academic and office campuses is a hot topic.
- Gray water systems received no attention.
- Despite this lack of interest, John Kennedy felt that water use would become a bigger issue in the future, especially given the increase in water rates through the MWRA (Massachusetts Water Resource Authority). He felt that water was undervalued and raising rates was a good opportunity for a government to generate revenue.

Interviewee: Stefan Lark
Company: Aspen West Mortgage
Role: Principal

Interviewer: Maia Hansen
Date: November 18, 1997

Notes

Background:

- Aspen West Mortgage is a 3-person independent mortgage company based in Santa Fe, NM.
- Most of his work is residential and deals with FreddieMac and FannieMAE
- His company has some experience in providing residential mortgages for alternative construction techniques.

Barriers to Green Building

- "Convincing financing groups that alternative construction techniques are viable." There are few comparables to be able to demonstrate that this type of work is marketable.
- There is no nationally recognized Green Builder program to deal with the federal mortgage programs and national private mortgage firms, such as Fleet, Norwest, etc.
- Alternative construction products - Rammed Earth, FasWall, and others are generally underwritten at a higher rate.
- There are no mortgage credits for better quality ventilation or other IAQ efforts.
- Solar power - especially for off-grid applications - is usually acceptable, and comparable to other off-grid systems, such as generators.

Possibilities for Green Building

- He thinks green building has a very strong future, which is based primarily at the grass roots level but spreading.
- He know of one realtor (Gary Hall of Home Field Realty in Santa Fe) who specializes in real estate for chemically sensitive clients.
- Realtors are very powerful and generally support green building initiatives "as long as they fit within typical architecture." For example, straw bale construction is acceptable in Santa Fe because it looks like the traditional adobe work of the region.

Interviewee: Ed Lowans
Company: Lowans and Stephen Environmental Consultants

and

Interviewee: Deborah Wright
Company: Canada Mortgage and Housing Corporation
Role: Senior Advisor, Research

Interviewer: Maia Hansen
Date: October 31, 1997

Notes

Background:

- Both Ed and Deborah do research on advanced building systems and look at issues of green building with psychology, health and safety.
- Some statistics:
    - Half of all health care costs are from environmentally caused diseases
    - Productivity studies have shown that green building produce 25% higher productivity. Studies include WalMart, Boeing, and ING Bank (Netherlands)
    - A 1990 study by the U.S. Academy of Science showed that 15 percent of the population is chemically sensitive.
    - In Canada, 20 percent of the population has asthma, up 30 percent from 15 years ago.
    - Other studies show increases in childhood allergies and infertility among male construction workers.

Expected Trends in Construction and Green Building

- There was a lot more thought put into older buildings than people realize.
- Green Building advocates know their own niche (such as straw bale construction, or solar panels) but do not study the broader changes in technology or market. "Many people in the green building field are focusing on old technologies and methods. People are not following common sense."
- Green building will benefit from a growing awareness of the population in healthy food and alternative medicine.
- Favorite manufacturers: Homosote, TrusJoist McMillan
- They also like Real Goods trading which provides an exchange for sellers and buyers of used building materials.
- Campaigns by the American Lung Association and other high profile groups are helping raise awareness.
- A wealthier, retiring community can afford to make green building investments.
- Coverage on the internet and educational television programs is increasing.
- Expect high future demand for recycled material content products and medium density fiberboard (MDF) which is formaldehyde free.
- The residential market is easier to address because most people are concerned with health issues in their homes, women make most housing decisions and are usually more interested in health issues. Nevertheless, speculative construction is less appropriate for green building.
- Commercial owners are aware of IAQ issues.

- Schools and Hospitals are generally not interested, unless there is a major problem, They are very conservative with building methods.
- For liability reasons, builders, architects, and specifiers could start requiring client signatures on waivers which identify potentially harmful chemicals used in building materials. This would raise awareness significantly among homeowners and others.

Barriers to Green Building

- Productivity gains are usually higher than cost savings in IAQ projects - but they are harder to measure upfront.
- The technologies for green building already exist, there is just a perception that they don't.
- There is a general lack of information. Information needs include:
    - Objective, reliable product analysis (like a Consumer Reports)
    - Need for "nutrition type" label.
    - Better source lists for materials
    - More uniform certification of products (this is expensive for small companies)
    - Green product guides
    - Analysis of green building options
    - Increasing coverage in journals and magazines.
- Even for the knowledgeable builder, "you need a spreadsheet to understand all the issues."

Distribution

- Leveraging the existing distribution network is best for green building producers. For example, Home Depot has broad market coverage and has started to do educational sessions on environmental and health issues.

Interviewee: T. Meyers
Company: Sasaki Architects
Role: Engineer

Interviewer: Maia Hansen
Date: November 10, 1997

Notes

Background:

- Sasaki is a 175-person architectural firm based in Boston which does design and planning work internationally.
- Current clients include Digital, PEPSICO, The Monitor Company, Raytheon, The town of Watertown, MA, the US Military Academy, and Martha's Vineyard Golf Club.
- Typical work is made up of 30 % campus planning (dormitories and sports facilities), 25% commercial (especially hotels and resorts), 15 % international, and the rest is a combination of interiors, renovations, and base closure work for military installations.
- T. Meyers has been with Sasaki for 17 years.
- Sasaki has always worked with a conservation ethic, including attention to flood planes and wetlands. Interior work usually includes daylighting, natural ventilation, and designs which minimize glare.

Trends in Construction and Green Building

- "Codes are a great help with recalcitrant owners."
- Helpful resources include
    - New computer programs which calculate net present value of building investments such as energy efficiency.
    - The Energy Star web page (by DOE) which provides useful and understandable information for both designers as well as owners. The extent of information and reputation of the program "legitimizes" efforts by the designer to incorporate energy efficient features.
- There is a trend to do more due diligence work early in the design process, rather than at the end, which was the norm in the past. This change relies on more product and financial information up-front.
- Most clients are "realizing that deferred maintenance is not a good idea."
- Some of his "best clients" - those that are willing to make smart, long term investments - are large institutions and large, high margin commercial companies. Specific examples include Brandeis University which recently built a $20 million sports facility and Putnam Investments which is renovating a former Digital facility in a suburb of Boston.
- Contractors and developers are also important in incorporating new building techniques. He finds that large commercial developers, and particularly those with a construction division, are the most savvy decision makers. (His favorites are Beacon Construction, Macomber, and Kennedy & Rossi) The small developer which is transitioning from the residential to commercial sectors are least savvy. They tend to rely on residential cost estimates for commercial work and often underestimate costs and investment needs.
- Barriers to Green Building include:
    - There is a need for more credibility.
    - Higher equipment costs
    - A lack of information: Most of his information comes from word of mouth, conferences, and the internet.

    - The average engineering firm relies too much on "cut and paste" in designing systems. This is partly to reduce liability and partly to lower overhead expenses.
    - There is a lack of innovation in mechanical and electrical systems. These fields have not kept up with the engineering strides in structural engineering.
    - Clients won't pay the fees and spend the money for engineers to design new systems.
- Developers are relying more on consultants now - instead of making all decisions themselves. In general, this is a good change, as long as the mix of consultants is good.

Indoor Air Quality

- Owners are much more aware of indoor air quality than they were a few years ago.
- Institutional clients are the most aware. He thinks this is because they have older mechanical systems which require more attention.
- Putnam Investments hires a New York air quality testing agency to monitor indoor air quality. This is to reduce liability risks, but also to catch problems early in development.
- His recommendations for investment in indoor air quality include improved control systems which monitor air temperature and other factors in smaller, discrete areas.
- Some of his clients hire management consultants to help in the design of new spaces. He has been surprised by how valuable they are in understanding the importance of indoor air quality and providing solutions. For example, one consultant had developed an algorithm for ideal temperature controls in different spaces.

Water Quality

- The hike in water rates from the MWRA is not enough to promote more water conserving technologies.
- Some clients are investigating gray water systems, but have not installed any.

Material Reuse and Conservation

- Some clients are interested.
- There are not enough recycled material options on the market, and not enough new product development.
- Renovations - especially the disposal of drywall and studs - still creates a lot of waste.

Interviewee: Larry Nelson
Company: Thermal Shell Homes
Role: Manufacturers Representative

Interviewer: Maia Hansen
Date: November 1, 1997

Notes

Background:

- Thermal Shell homes are made with panels of OSB skins over expanded polystyrene cores.
- Shell Homes has approximately 100 manufacturer in the U.S. with varying types of finished products. Some produce 4' by 8' foam core panels and some produce entire walls with framed window and door openings.
- A 2000 SF home built with Thermal Shell will have significant energy efficiency savings. The highest air conditioning bill is advertised to be $46 per month.
- Several subsidiaries are part of the company, including AFM (American Foam Manufacturers) which has 20 plants, Core Wall which has 1 plant, Intercept with 1 plant, Insulspan with 10 plants, and Thermalsave with 2 plants.

Expected Trends in Construction and Green Building

- Energy conservation and indoor air quality will be most important.
- Durable products and products which have less impact on natural resources will also be important.
- Residential builders are more willing to pay premiums for healthy related features. Commercial builders don't care and are more concerned with the bottom line.

Interviewee: John Kennedy
Bill Morash
Michael Skeldon
Company: Kennedy & Rossi

Interviewer: Maia Hansen
Date: November 4 1997

Notes

Background:

- Kennedy & Rossi is a construction manager / developer which specializes in commercial and institutional construction in the Boston area. They do no public or residential work.
- The interview was structured around details of four current projects which collectively represent a typical range of their work. These projects were as follows:
    1. Office conversion for Tufts Health Plan in a leased facility in Watertown, MA. Building began as a rough warehouse of approximately 500,000 SF. The contract is worth approximately $20 million dollars with an additional $10 million parking garage. Decisions are made jointly with the builder owner, the long term tenant (Tufts), the architect, and Kennedy & Rossi.
    2. An office and production facility renovation for the Genetics Institute - a biotechnology firm. Contract value is $2 million. The lease is only three years, and hence investments are minimal.
    3. Small renovation project for MIT. Typified as "ultra-long term" investors.
    4. Groton Preparatory School athletic center. Mostly new construction with some renovation. Contract value approximately $20 million. Decisions are made primarily by the architect with great input from the trustees and some from Kennedy & Rossi. The investment horizon is very long term and focuses primarily on aesthetics, not equipment.

Green Issues in General

- "The more picky tenants tend to be technically inclined and more likely to have a staff to work with facility issues." large = more sophisticated.
- "Schools wouldn't possibly think about this."
- "Commercial developers are most sensitive to costs, institutional clients least."
- 5-10 years trends:
    - "Indoor air quality has not hit a peak yet. It could be like asbestos, and be stuck at the mercy of legal risks. Owners are concerned about liability, such as in the Motor Vehicles building."
    - It is "hard to go to far from the main stream."
    - "Energy conservation is stagnant."
    - "Water is a limited resource and therefore could be important, but currently I'm not sure how much else you can do."
    - "The marketing opportunities with buildings like 4 Times Square are a good idea fundamentally - within reason."
- Preferred investments:
    - Indoor air quality - monitoring, control, products
    - Replacement for dimensional lumber and sheetrock - commodities that fluctuate in price.
    - Better designed systems. "Buildings are not designed like a car. They are done in pieces with no clear responsibility."

Indoor Air Quality

- "90 percent of clients ask about it."
- Clients are focused on the quantity of fresh air in the building and dehumidification.
- Chemical emissions of finishes and furniture is addressed by installing these items earlier so that they can off-gas more before building occupants more in and by turning on the air system earlier. Many clients have a third party industrial hygienist test and document the air quality before move-in to show to employees.
- Pharmaceutical companies and hospitals are mandated by FDA requirements to meet high levels of air exchange. In operating rooms and pharmaceutical production spaces, 100% air exchange is required. No recycling is allowed.
- "Schools follow the open window method of indoor air quality." Nevertheless, there is "always someone interested" in air quality.
- In the Groton athletic center, air handling was a major importance, particularly because the facility included an ice rink which required a Zambone. An electric powered (vice propane powered) Zambone was purchased to reduce fumes inside the building. In addition, the capacity of the mechanical equipment was increased by 25 percent.
- In the Tufts facility, the tenant requested that the air handling system be enlarged. Kennedy & Rossi suggested that a heat pump would be just as effective, and more energy efficient. Nevertheless, Tufts chose the air handling system, because of a perception that more CFM is better.
- Large architectural firms are developing a more keen eye with respect to liability. There staffs are now better able to handle IAQ issues.
- The largest product needs were
    - carpets, furniture, and partitions which had arrived with all or most of the VOC's dissipated.
    - more efficient heat exchange systems (the current ones get dirty quickly and take over three years to create a payback)
- Another desire was a true standard for fresh air.
- They had one client with a sick building. The solution was to change the air handling equipment and relocate the intake for outside air.
- Future trends are expected to be a focus on bigger air handling units - preferring air quality over energy conservation.
- "Indoor air quality problems are solved with equipment. Architects don't work with it. They just pass it off to engineers and architects who choose the equipment. To make things worse, the engineers think the equipment is better than it is."
- There was no sense of any new products on the market or of advances abroad. They did note that the European system for building design was more logical and therefore might result in better quality designs for ventilation.

Energy Conservation

- "90 percent of clients ask about it, but then only 10 percent decide to act on it."
- "There is an awareness, but no leap of faith."
- "The tenant pays the electric bills, but the building owner invests in the equipment."
- The engineer approach is to install lights with auto dimmers, and motors with variable frequencies.
- The utility approach (especially in this time of deregulation) is to back away from credits and look more at "realistic paybacks" such as dual feeds for electricity and gas.
- Owners are most worried about maintenance issues and long term livability
- Architects see diminishing returns to energy efficient features. They may look at specialty windows but then decide that the existing energy efficient windows are pretty well designed.
- Opportunities for improvement exist with fine tuning operations so that lights are isolated and only used where needed.
- Daylighting in design is popular, but more for appearance than for energy reasons. "The lighting consultant will probably still design the system for the cloudy day in January and the lights will stay on the rest of the time."

- Insulation and roofing are already well engineered. "They are now driven by code and no one is out trying to reinvent them."
- Alternative energy is not much in demand.
- There is a stigma with solar panels that they have poor aesthetics and are just a fad from the '60s or '70s.
- A former project with Children's Hospital used solar panels, but other than that they have had no discussions with clients about the relative merits of any alternative energy technologies.
- "There is little public relations on alternative energy."
- Geothermal systems had been used by two clients in the past - a retirement community far outside the city and the Union for Concerned Scientists in Harvard Square. The latter chose it, "despite a 10,000 year payback."
- Some clients have looked at cogeneration, but decided against it because it would be one more operations requirement outside of their core competency.

Material Reuse and Conservation

- Very few people ask about this - maybe 10 percent at most.
- Asphalt is recycled, as is wallboard on the home building side.
- Structural steel and copper are carefully segregated and then sold as scrap. (They use the proceeds to fund the annual Christmas party, etc.)
- The labor costs for sorting are higher than any revenues from saving other construction waste.
- There is no exchange of scrap materials between construction sites or other buyers and sellers.
- They can't imagine a wholesale reuse of wide flange sections - the handling expenses would be too expensive.
- They tried reusing brick once, but it was too difficult to match with new sections. They were persuaded to buy new brick, rather than paying the mason to do the matching.
- Tufts looked at buying ceiling tiles made of recycled material, but decided against it because they liked another style. The fact that it was made from recycled material wasn't that important.

Water Conservation

- In general, water conservation is most important to their pharmaceutical clients which use a lot of filtered water in their process and produce a lot of wastewater. Water treatment becomes one of their highest costs. "They buy water for much less than one cent per gallon and then treat it for five cents." The process is very well defined by the FDA, leaving little room from the engineering side."
- 1.8 gallon (low-flow) toilets are unpopular and clients complain about them. They have no complaints about low flow shower heads.
- Most clients assume water conservation techniques are mandated.
- Commercial kitchens, despite using a lot of water, are not very concerned with water conservation.
- Landscape irrigation at academic and office campuses is a hot topic.
- Gray water systems received no attention.
- Despite this lack of interest, John Kennedy felt that water use would become a bigger issue in the future, especially given the increase in water rates through the MWRA (Massachusetts Water Resource Authority). He felt that water was undervalued and raising rates was a good opportunity for a government to generate revenue.

Interviewee: Mark Richmond Powers
Company: City of Austin, Green Builder Program
Role: Director

Interviewer: Maia Hansen
Date: October 28, 1997

Notes

Background:

- Professional background in conventional construction, straw bale construction, ESCO retrofits with a utility program in Denver, Green Building consultant to architects in Los Angeles.

City of Austin Program:

- Began five years ago as a development from an energy rating / energy star program
- Recognized by the United Nations as one of the 12 most innovative programs in the world for environmental initiatives. (details, date)
- Currently have a staff of nine.
- Funding comes from 85% municipal utilities (Austin Electric Utility) and 15% from various city offices.
- Goals - education of the community, rating system for differentiation, list of green builders in the area, track costs and products, training, education, teach seminars.
- Primarily focused on the residential sector - (80% of work)
- Green homes currently constitute 5% of residential construction and 1 to 2 % of commercial.
- Austin area is growing rapidly - 600 new homes built each year. High growth in high tech industry.
- Austin has experienced a growth in environmental interests for about ten years. High tech industry companies and employees are particularly involved.
- Austin has developed green municipal guidelines.
- Consumers learn about aspects of green building through internet searches, television or ratio programs, articles in local paper.
- Local realtors involved - apartment finder flyers have green building logo next to specific multifamily buildings constructed through the program.
-

Expected trends in Green Building for the next five years:

- Increasing interest in Indoor Air Quality caused by lawsuits, and baby boomer interest in the health of their children. Particular focus on growth in allergins, mold and mildew, holistic health.
- Consumers are actually less energy efficient than they used to be.
- Slight increase in quality and durability - slower turnover in homes as people move less.
- Indoor Air Quality interest moving from commercial sector to residential sector.
- Educated customers are extremely loyal to green building - seek out green builders and materials
- Some consumers seek out green builders because some of their work looks like adobe houses and the homeowners like that aesthetic.
- Expects commercial sector to be less interested in Green Building than the residential sector. Commercial market has a split in decision making between tenants and building owners. Each has a distinct time frame. Decisions are very short-term for developers and only long term for owner-occupants.

•

Barriers to Green Building

- Buyers not asking the right questions.
- Builders more resistant to Green Building than consumers
- Realtors are very important to homeowner decisions. - the Multiple Listing Service is the number one source of information for buyers.
- Green products often have a 10 % price premium over conventional products.
- Generally there are no economies of scope
- Over 75 percent of green building products come from small producers.
- Products are difficult to find. Most are purchased directly from manufacturer and locating them is facilitated by word of mouth - informal sources like professional at the Green Builder program, other professionals.
- Normal building material suppliers don't put an effort in stocking green products. - Many green products need to be explained to builders and consumers and the lumberyards, etc. don't want to add resources to facilitate this learning process.
- Builders unwilling to take risks on new materials for product failure risk.
- Architects are more interested in Green Building, but have difficulty finding material specifications.

Best approaches to Green Building - With little price premium over conventional custom construction

- Passive Solar Design - House orientation, roof overhangs
- Rainwater Collection
- Tightly sealed ductwork
- Increased quality windows
- Use of low-off gassing materials
- Increasing hard surfaces instead of carpets
-

Exciting New Products/Services

- Focus on Indoor Air Quality - mold and mildew, off-gassing, HVAC filters, elimination of leaks in insulation and ductwork, attic venting
- Homosote
- Cool Ply
- Glidden Spred 2000
- Andersen high efficiency, lumber conserving windows
- Hardy Products - cement based siding and other products.
-

Most mature / well designed product:

Biggest product need:

Favorite Investments: LBO consolidation, professionalization of several green producers to reach economies of scale. .

Interviewee: Amy Townsend
Company: Sustainable Development International Corp.

Interviewer: Maia Hansen
Date: November 1, 1997

Notes

Trends in Green Building

- Green building is the fastest growing segment in the construction industry
- The focus is most on improving health and resource efficiency (closing the waste loop and lowering life cycle costs)
- The American Lung Association and other medical agencies are becoming more involved. The ALA sponsored the construction of model healthy buildings in September 1997.
- Commercial green building is likely to be most successful because better systems often are less expensive than their traditional counter-parts.
- Residential construction, on the other hand, has fewer areas to cut. The final house will be about the same price or slightly higher.
- Examples of green building have documented increased productivity and increased energy efficiency
- Quantitative data is very new.
- The Audobon building was very well marketed and helped move green building to other organizations.

Barriers

- Lack of education - building owners, facility managers, accountants
- Lingering belief that green building is more expensive than traditional construction
- Lack of a specific definition
- Lack of understanding by businesses of the costs of maintenance, etc. "They assume the traditional costs of utilities, water are given and that there is no room for improvement."
- Commercial for-profit companies hesitate to share their programs to save energy because they don't want to lose cost advantages that they have over their competition.

Summary of the Atlanta Home Building Association Green Building Survey

In December 1997, the Greater Atlanta Home Builders Association distributed a green building survey to a small group of its members. This survey was intended to gauge the perceptions and practices of builders with respect to environmental and health aspects of houses. The builders were not pre-selected for an environmental focus.

The Atlanta HBA was chosen as a participant in this survey because it is in the process of developing a Green Building Program and it is one of the most active residential construction markets in the U.S.

Description of Survey Participants

A total of six companies completed the survey. Of the six, four were builders and two were builders and developers. All six work primarily on the new construction of single family homes in suburban areas around Atlanta. The largest builder built 300 homes in 1997 and employed 60 people; the smallest built 5 homes and employed only one person. There was a range of housing prices, from less than $100,000 to $400,000, with the average being approximately $190,000. A slight majority (55%) of the homes were pre-sold, with the remainder being speculative (45%). Custom home building accounted for less than 0.5 % of all construction.

Selection of Building Materials

Depending on the size of the builder, selection of building materials is made by either the company owner (in small companies) or by a manager of building operations, purchasing or estimating (in large companies).

Perception of Demand for Green Homes

Five builders replied that less than 5 percent of clients have expressed interest in green building products and designs. The one builder claiming that 5 to 15 percent of clients express interest is also the only builder to advertise green aspects of homes. (Another builder responded that they do "not yet" advertise green aspects of homes.) Energy efficiency, healthy environments, and longer product life cycles were perceived as being most important to their clients. This is born out in the following list of green home attributes, where 1 is considered "very important" and 5 is "not important." (One builder did not respond and is excluded from this calculation.)

• Energy efficiency	2.2
• Health benefits	3.0
• Longer product life cycles	3.2
• Non-toxic materials	3.8
• Sustainable production methods	3.8
• Resource conservation	3.8
• Recycled content of materials	3.8
• Water conservation	4.0

Use of Green Products and Design

Three of the builders have changed material selections in the past for environmental or health reasons. Only one has changed designs. Of the list of possible green building materials, the only products consistently mentioned were engineered wood structural components and continuous ridge and soffit vents. Following are the percentages of respondents who have specified a specific green building product in the last year:

• Continuous ridge and soffit vents	100%
• Engineered wood components	83%
• Specialty air / water filters	33%
• Sustainably harvested lumber	17%
• Composite decking or panels	17%
• Recycled roofing or siding	17%
• Alternative wall systems	17%
• Low-E windows	17%
• Compact fluorescent lighting	0%
• Non-fiberglass insulation	0%
• Recycled PET carpet	0%
• Gray water systems	0%
• No-VOICE paint	0%
• 14 SEER air conditioning systems	0%

Information on Green Products

Only two builders noted that they would like to see more information on green building, in the form of articles, case studies and consumer studies. The builders surveyed presently use a range of sources of information on green building products, including lumberyards (83%) , manufacturers reps (66%), trade journals (50%), trade shows (50%), and Sweet's catalog (17%). None referred to colleagues or green product catalogs.

For general information, all read *Builder Magazine* regularly. *Professional Builder* was next in popularity (83%), followed by *Builder-Architect* (67%) and *Fine Home Building* (33%).

Suppliers

The most common main supplier was the locally-based lumberyard (100%). The largest builder, however, also works with distributors and purchases materials directly from the manufacturer. All were generally satisfied with the service and material selection provided by their supplier (average rating of 2.2). For specific green building products, these builders use their lumberyard or may go through a distributor. In rating different versions of green product supply, there was no uniform preference. Many preferred distribution through existing suppliers, though some were interested in a consolidated representative for green products and others thought an internet-based green building product distributor would be valuable.

Technology

All builders have access to the internet and have a computer with a CD-ROM drive. Only one had ordered any kind of product or service from a web site. Interestingly, this builder is also the only one who advertises green building features in his homes.

Conclusion

In comparison to surveys from other regions, this small sample of builders was least active in building or marketing green elements in homes. The most popular products indicate a reliance on traditional solutions to energy efficiency and resource conservation. All of the builders, however, were somewhat interested in additional green products and resources.

Summary of Austin Surveys of Builders and Architects:

Six builders or architects were surveyed at the Austin Green Builder Conference in Austin, TX in October 1997. While all were self-selected based on their attendance at the conference, each sets different priorities.

Description of survey participants

Three of the participants were builders or developers. One was a design-build architect and two were architects. Three worked primarily in Austin, one in Santa Fe, one in the Gulf Coast states, and one nationally. Most focused on residential work and built less than 15 houses per year. Most houses were custom, built in a rural area, and ranged in price from less than $100,000 to $500,000. The largest firm employed 33 people; most employed under ten.

Selection of Building Materials

Because of the custom nature of the house, owners, architects, and builders participated jointly in selecting building materials. Clients were generally willing to pay a slight premium (at most 20 percent) for green features.

Perception of Demand

Client interest in green building was generally very high (over 75% for four out of the six respondents). One noted that interest was 25% to 50% and one estimated only 5% to 15%. All green features received above average or average rankings. The following list of green home attributes recognizes the perception of client demand. 1 is considered "very important" and 5 is "not important."

• Energy efficiency	1.0
• Health benefits	1.5
• Longer product life cycles	1.6
• Non-toxic materials	1.8
• Sustainable production methods	2.3
• Resource conservation	2.5
• Water conservation	2.6
• Recycled content of materials	3.1

Use of Green Products and Design

Since most of the work is custom, material selection and design is tailored to individual needs. All respondents advertise environmental and health aspects of their work. In addition, all of the green building products listed on the survey were used by at least one of the survey respondents. Products used by all six were engineered wood structural components, alternative wall systems, and no-VOC paint.

• No-VOC paint	100%
• Alternative wall systems	100%
• Engineered wood components	100%
• Sustainably harvested lumber	83%
• Low-E windows	83%
• Non-fiberglass insulation	66%
• Specialty air / water filters	66%
• Composite decking or panels	66%
• Recycled roofing or siding	50%
• Continuous ridge and soffit vents	50%

- Gray water systems 50%
- 14 SEER air conditioning systems 50%
- Compact fluorescent lighting 33%
- Recycled PET carpet 17%

Independently mentioned products were rainwater catchment systems, straw bale construction, solar power, and wind power.

Information on Green Products

All but one respondent would like to see more information on green building products and designs. Articles, case examples, and consumer studies were particularly in demand. All possible sources of green building information were used, with trade journals and professional colleagues being the most common sources (both 83%). Other sources were manufacturer's reps (66%), green product catalogs (66%), trade shows (66%), lumber yards (33%), and *Sweet's* (33%). One builder uses the City of Austin Green Builder Program, the Sustainable Builders Coalition, and the Center for Maximum Potential Building Systems for additional resources. Desires for specific green building product information included product descriptions, technical specifications, performance characteristics, review of environmental claims, product "recipes", and building techniques. Pricing and local supplier information are important to some and less important to others.

General building information is found in a wide range of regularly read trade journals. 66% read *Builder Magazine* regularly and 33% read *Fine Home Building*. Other sources of information are *Architectural Record* (33%), *The Journal of Light Construction* (33%), *Texas Architect,* and *Environmental Business News.*

Suppliers

The lumber yard was the most common source of supplies, though all respondents also work with either a distributor, manufacturer or home center. Green building products were purchased from similar sources. Distribution networks of these supplies were split between local and national. There was less satisfaction (average of 3.0) with suppliers in this group than with the Atlanta builders.

Response to the question on new types of green product distribution was inconclusive. Based on responses from only four participants, the consolidated manufacturers representative was rated 2.75 (where 1 is the best and 5 is the worst), internet distribution received a rating of 3.0, existing distributors received a rating of 3.25, and the specialty distributor a 4.5.

Technology

The three respondents who answered these questions all had CD-ROM drives and access to the internet. One had ordered a product from a web site.

Conclusion

Of the three surveys, this small group of builders and architects in Austin is certainly the most active in green building. While the use of specialty green products is high, unmet demand exists for widespread distribution of products and more high-quality information.

Summary of Austin Surveys of Green Building Product Manufacturers

Seven manufacturers representatives or company presidents were surveyed at the Austin Green Builder Conference in Austin, TX. While all produce green products, some are more specialized than others. The companies surveyed were Collins & Aikman (carpet), TrusJoist McMillan (engineered lumber), American Thermashell (alternative wall systems), Kelly-Moore Paint Co. (paint), Thermal Seal Inc. (installers of Icynene insulation), Icynene Inc. (insulation), and American Rockwall (insulation).

Description of survey participants

All but one of the companies are privately owned. TrusJoist is public and trades on NASDAQ. Six producers sell to both the residential and commercial markets, while one (Collins & Aikman) targets only the commercial market. All have national or international distribution. Market sizes ranged from $7 million at American Rockwall to $700 million at TrusJoist.

Perceptions of Industry Trends

Consumers: One respondent noted that "consumers are becoming more educated on green issues and are particularly interested in comfort, health, and energy efficiency." The survey showed that health was very important, but resource conservation and longer product life cycles out weighed energy efficiency.

• Non-toxic materials	1.7
• Health benefits	2.0
• Resource conservation	2.1
• Longer product life cycles	2.3
• Energy efficiency	2.4
• Sustainable production methods	2.8
• Recycled content of materials	2.8
• Water conservation	3.4

Non-environmental priorities for clients are residential design options which require longer spans and simplified procurement options for commercial clients. Important technology changes included the development of less toxic materials and products which require less lumber. In some industries, value chains are consolidating and becoming less structured, including market entry by manufacturers into contracting and by distributors into manufacturing,

Sales and Marketing

Most green products by these producers are competitive with traditional products or have a slight premium, with at most a 2 to 3 year payback. Four producers sell through exclusive manufacturers representatives. Kelly Moore sells through independently owned stores with a dedicated sales force. American Rockwall has its own sales force; and Icynene sells through licensed contractors. All advertise in trade journals. Some also advertise in *This Old House*, *House Beautiful*, *Popular Science*, and others. Only TrusJoist advertises in *Sweet's*, while others felt this option was "too expensive." Advertising budgets were generally 1 percent of sales, though this information was disclosed by only three respondents.

Distribution

Collins & Aikman, Icynene, and American Thermasheel ship products directly to the contractor or building site. TrusJoist ships to a distributor. Kelly Moore distributes through company-owned stores. Few of the producers felt that a new "virtual" distribution channel

was needed. TrusJoist and Collins & Aikman were most interested, but more as an avenue to distribute information, not as a true ordering tool.

Desires in a New Product Catalog

All producers were interested in being listed in a new product catalog and in receiving a catalog as a source of competitive information. There was no preference among publication options - hard copy, CD ROM, and Internet were all popular. The inclusion of product brochures and performance characteristics were noted as being most valuable. Bimodal responses were received for pricing.

• Product brochures / descriptions	1
• Performance characteristics	1
• Building techniques	1.8
• Technical specifications	2
• Nearest supplier	2.6
• Review of environmental claims	2.6
• Pricing	3.2
• Product "recipes"	3.8

Important additional information included case studies. Annual updates were preferred. All could update information on-line, if needed.

RESULTS OF THE DENVER HBA GREEN BUILDING SURVEY

Compiled by Paul Christiansen, Neighborhood Progress, Cleveland, OH

In November 1997 the Home Builders Association of Metropolitan Denver distributed surveys to a limited number of its members to obtain a "quick read" on the interest and activity levels in green home construction. This report summarizes the results of the survey. It should be noted that due to the small sample size, the figures reported in this document may not accurately reflect the actions and opinions of the entire HBA membership. Nevertheless, the results are a useful indicator of general trends and overall patterns shaping the environmental building industry in the metro Denver region.

Sample Population:

A total of 11 companies completed and returned the survey instrument. Eight of the respondents were builders, two were remodelers, and one was a builder / developer.

The firms range in size from a production volume of 10 houses per year to over 1,100. The average company has 54 employees. The firms all work exclusively within the state of Colorado with some of the smaller organizations limiting their operations to a single city, like Denver or Boulder. 95% of their work is focused on new construction of single family homes, and the majority of companies are building in suburban locations. Custom home building accounts for 43% of total production. The average price of their new homes is $268,000, and the average cost of a remodeling project is $61,000.

Green Building Practices:

According to survey respondents, roughly 20% of home buyers / renovators express interest in green building methods and materials. The results are somewhat bimodal, however, in that a majority of the companies (6 out of 11) say that fewer than 5% of their clients ask about environmental features in their homes.

The most important characteristics in a green home are energy efficiency and health-related features. The following list of green home attributes are ranked on a 5-point scale where 1 is considered "very important" and 5 is "not important."

• Energy efficiency	1.5
• Health benefits	2.0
• Non-toxic materials	2.1
• Longer product life cycles	2.3
• Sustainable production methods	2.6
• Resource conservation	2.7
• Water conservation	2.8
• Recycled content of materials	3.0

55% of builders / remodelers claim to advertise the green building techniques and materials that they employ. The most common methods are newspaper ads, promotional brochures, and custom sales presentations.

Some of the most commonly used green building materials are listed below with the percentage of respondents who have specified the product in the last year.

• Engineered wood components	100%
• Composite decking or panels	82%
• Low / no-VOC paint	64%
• Low-E windows	55%
• Recycled roofing or siding	55%
• Sustainably harvested lumber	36%
• Compact fluorescent lighting	27%
• Specialty air / water filters	27%
• Non-fiberglass insulation	27%
• Recycled PET carpet	27%
• Continuous ridge and sofit vents	27%
• Alternative wall systems	9%
• Gray water systems	9%

The biggest barriers to greater acceptance of these environmentally-friendly products are high cost and lack of customer demand. A full 82% of survey respondents cite price premiums for green materials as a major obstacle while another 73% say customers just are not interested. As one builder succinctly states, "Customer demand is currently low, and costs are high." Product quality and availability were also mentioned as problems but only by a small number of companies.

Green Product / Material Information:

At the same time, most builders / remodelers (64%) say they would like to have more information about green building practices (e.g.: articles, case examples, consumer studies). The most commonly used sources of green building product information are listed below.

• Trade journals	91%
• Professional colleagues	64%
• Lumber yards / distributors	55%
• Manufacturer / sales representatives	55%
• Trade shows / conferences	55%
• Green product catalogs	36%
• Sweets catalog	18%

As for the most popular trade journals, over 90% of respondents read *Builder Magazine* and *Professional Builder*. 45% subscribe to *Builder-Architect*, and 27% read *Fine Home Building*.

Suppliers:

Builders and remodelers tend to rely on their regular suppliers for their green building product needs. 100% of respondents say they look for green products at their local lumber yard. 67% source materials from a distributor, and 33% order direct from the manufacturer.

Overall, respondents say they are pleased with the material selection and service of their local supplier. 60% claim they are very satisfied with their suppliers while 40% feel they could do a better job in bringing new materials to builders' attention. As one builder states, "Many of my material suppliers are slow to carry and promote new products, but are generally good at researching and obtaining products that I ask them for." 76% of respondents, however, indicate they would be willing to shop on-line or order direct from an organization that carries a broader selection of green building products so long as prices are competitive and delivery service is reliable.

Conclusion:

While it is difficult to generalize from such a small sample size, the results of this brief study indicate that green building is still a relatively small, niche-oriented business. Many builders and remodelers are clearly interested in green products / materials and feel there is a marketing advantage to building green. The broader market, however, appears to be constrained by perceptions of higher cost and lack of customer awareness. The HBA of Metropolitan Denver will continue to address these challenges in hopes of achieving broad-based acceptance of green building as a sensible, cost-effective construction practice.

Appendix G: Summaries of Interviews and Conference Visits by Core Resources and Environmental Advantage Capital

Energy Efficient Building Association Conference was written by Paul Christiansen of Neighborhood Progress for Core Resources.

Commercial / Institutional Green Building Sectors Overview was written by Rachel Crossley of Environmental Advantage Capital.

ENERGY EFFICIENT BUILDING ASSOCIATION CONFERENCE
Denver, CO
November 7-8, 1997

LIST OF INTERVIEWS

Manufacturers

GreenStone / Louisiana-Pacific (large, national company)	Tom Ward & Harold Shepard	Producers of Cocoon brand cellulose insulation
Tamarack Technologies, Inc. (small firm in Massachusetts)	David MacLellan	Manufacturers of residential ventilation systems
Vaughn Manufacturing (small company in Massachusetts)	Kenneth Ladd	Makers of super efficient water heaters and heat recovery units
Nutech Energy Systems (medium sized firm in Dayton)	Robert Ferris	Producers of home ventilation and heat exchange systems
Sherwin Williams Co. (large, national company)	No name available	Manufacturers of low/no VOC paints and other finishes
Lava Block and Brick (small, start-up firm in Colorado)	Ken Detjen	Maker of lava rock wall and foundation systems

Builders / Remodelers

Wonderland Custom Builders (based in Boulder, CO)	Jim Leach	Large custom home builder doing work across the country
Jack Guren Remodeling (sole proprietor from Boulder, CO)	Jack Guren	Remodeler doing mostly high end residential work across the country
McStain Enterprises (large company based in Boulder)	Kristen Shewfelt	Large production builder working throughout Boulder County
Kurowski Development Co. (based in Denver)	John Kurowski	Medium sized residential builder working in Denver
RW Custom Homes (based in Denver)	Rick Wildrick	Medium sized builder of custom green homes
Synergy Design (small one-man outfit in Colorado)	Matt Worswick	Architect / Designer of green co-housing projects
Big Horn Builders (small firm from Boulder, CO)	Doug Parker	Small builder / remodeler of high end homes in Colorado

Distributors / Retailers

Planetary Solutions (small firm from Boulder, CO)	Sarah Francis	Retail supplier of green interior design products (e.g.: flooring)
Eco-Products (small firm in Boulder, CO)	David Adamson & Chris Pfeifer	Local suppliers of green building products and materials

SUMMARY OF INTERVIEW NOTES

Ideas for the Product Catalog

Most people interviewed said they would like to see the catalog on CD-ROM. There was less interest in an on-line / internet product.

Several builders recommended that we create multiple editions of the catalog - one for residential builders and remodelers, one for commercial builders / contractors, and one for homeowners. We may not need a homeowner edition, but we should make sure the catalog is easy to use for the average lay person since a number of builders said they would share the directory with their clients.

One of the most valuable pieces of information the catalog can provide is local supply locations. As one builder said, "I can get on the internet and find all kinds of fancy new products and materials. What I need to know is where to find these products locally." The spring or summer edition of the catalog should include a list of supply locations in major metropolitan areas for every product listed.

We should include a green builder "checklist" like the ones from the E-Star program or Austin's green builder program. The less sophisticated builders want to know "what five things can I do cost-effectively to make my homes green"?

Many interviewees said what they really wanted was a tool to help them make product / material selection decisions. "The catalog is a nice encyclopedia, but I'd like something that can help me pick which of the five listed roofing materials is best for my project." The current catalog does supply price and some performance data, but perhaps we can develop a prioritization worksheet or software program to assist in decision-making. This could be developed separately (with government grant support?) and sold as an add-on to the catalog.

Many builders want to see field testing information included in the catalog. The EBN product database allows us to track such information, but the manufacturers will be reluctant to have negative feedback published in the same directory in which they are paying to advertise. Perhaps product performance / field reviews could be a separate line of business. Either way, the current catalog should have tear-out feedback forms for builders to report on product performance.

We should advertise the catalog in a number of high profile trade journals. Everyone (from builders to manufacturers) reads periodicals like Builder and Remodeling magazines.

Most people wanted to see case studies and related design articles included in the catalog. One idea is to sell package subscriptions to both the EBN newsletter and product catalog. That way people get both product information and in-depth articles, and we have a better chance of selling annual catalog updates when people call to renew their EBN subscription.

We might want to include a section listing green builders and remodelers. One person said it would be helpful to know who the green builders are around the country. It could be a networking tool for builders and a lead generator for the manufacturers.

Many builders want help in how to market their green homes (e.g.: measuring the IRR on green product investments). Again, we could include this kind of information in the catalog or sell it as an add-on feature to the catalog.

Manufacturer / Distribution Notes

Every type of green building product has its own unique distribution system, and within product categories, each manufacturer has its own unique set of distribution options. For example, cellulose insulation is sold through distributors to insulation contractors while engineered lumber is sold directly to lumber yards from the manufacturer.

The typical manufacturer distributes products through a number of different channels. One company might have 4 or 5 different distribution methods: direct to builder / contractor via UPS or by truck, through wholesalers / distributors, through retail outlets like DIY, to other OEM equipment makers, and through specialty dealers (like HVAC dealers).

The larger manufacturers like Louisiana-Pacific and Sherwin Williams have their own distribution networks. They still might use wholesalers in some parts of the country, but most of their product is shipped direct to retail outlets (e.g.: lumber yards, paint stores).

A lot of the smaller manufacturers rely on direct sales. There are no distributors or suppliers that carry their products. They list their products in

specialty catalogs, use manufacturers reps, advertise in trade journals and attend trade shows.

The smaller companies seem to be dissatisfied with the effectiveness of their manufacturer reps. They claim the reps don't know the products well enough, provide poor customer service and aren't hungry for new business.

None of the manufacturers I interviewed listed their products in a green product catalog. In fact, one said they recently pulled out because they felt it was more cost effective to advertise in trade publications. That means manufacturers will likely treat the product catalog just like any other advertising expense, weighing cost against reach and effectiveness in the marketplace. We need to find out what manufacturers currently spend on advertising and develop a compelling cost-benefit argument for the product catalog.

According to several manufacturers, the distribution chain typically marks up the price of a building product 20-30% at each stage. For example, if a product costs $1.00 to make, the manufacturer sells it to a wholesaler / distributor for $1.25. The wholesaler sells it to a retail outlet / dealer for $1.50. The retailer sells it to a contractor or builder for $1.75 who then sells it to the homeowner for $2.00.

Many of the small manufacturers liked the idea of a new green building product direct sales channel. They would be willing to sell direct to customers provided they were not going to cut out an important regional distributor by doing so.

Builder / Remodeler Notes

Most of the residential green building work is being done by custom builders with affluent customers who are looking to build a green home. Only a few production builders have signed up for the green building programs in places like Boulder and Austin. Even McStain Enterprises, a production firm that has built over 4,000 homes in Colorado, has only done one small green subdivision. This is still a very small niche market (roughly 5% or less of builders / remodelers interested in green building).

Most builders are familiar with the competing green product catalogs that exist. The best ones in their minds are the regional directories which provide local sources of supply for green products and materials. They readily admit,

however, that no existing catalog is considered the authoritative source for the green building industry. This should be our objective.

The most important selling features of a green home are energy efficiency (saving homeowners money), health and comfort. According to McStain Enterprises, "energy efficiency is by far the most positive selling feature for our green homes, more so than even indoor air quality."

Green homes don't have to be more expensive. There are a number of affordable green home projects being built around the country. One such development in Aspen, CO involves 22 homes that cost only 4% more than a conventional housing project.

Green homes now qualify for special mortgages from banks like Norwest and Chase that permit home buyers to borrow up to 5-20% more for a home purchase. Some loans even have lower interest rates and fewer up front points.

Most builders liked the idea of buying green products directly through a new service, especially for hard-to-find items. The more commonplace products like engineered lumber, however, will still be purchased through local lumber yards. In fact, one builder said there's a strong "old boy's network" that exists between builders / contractors and their suppliers. This new supply service would have to be extremely price and service competitive to succeed.

Other Related Green Business Ideas

1) Create a new direct sales channel, linked to the green product catalog, to sell products direct to builders / contractors. We could establish a network of existing distributors who agree to carry inventory of our green products. We would probably want to start out small in a limited geographic area with a limited number of products. If successful, we could expand from there. We would have to be able to provide technical service and prompt delivery. In order for the economics to work, this business would have to eliminate at least one step in the distribution chain (e.g.: Amazon.com).

2) Establish a green product manufacturer sales rep business. Most small manufacturers are unhappy with their current reps. We could create a nationwide sales force to rep select green products. This team would have to have a high degree a technical expertise across product lines and be highly service oriented.

3) Create a "Consumers Reports" testing and performance business for green building materials. Utilizing EBN's expertise and reputation for objectivity and credibility, we could do product testing and field reporting on the performance of various products. Many builders said that one of the barriers to new green products is the lack of such field test information.

4) Set up Green Building showrooms around the country. Some people are already trying to do this in places like the Eco-Smart Building Center located in Trump tower. The idea is to charge manufacturers to display their products in a highly visible demonstration project that builders and architects then visit to get new product ideas.

5) Create a green home marketing company. Nearly every builder I spoke to was having trouble marketing the consumer advantages of their green homes. Many would be willing to pay a consultant to help them create marketing strategies and materials. This new business would be a close fit with What's Working, only on a larger scale.

6) Develop a private label line of green products. Some suppliers are already doing private label deals with well-known companies (e.g.: a small ventilation equipment manufacturer creates products under the Lenox and Honeywell names). We could establish a new brand name synonymous with quality environmental products. Perhaps Green Seal has already looked at an idea like this.

7) Pursue an industry consolidation strategy. Some players are actively trying to consolidate fragmented market segments to achieve economies of scale, establish a national presence and create strong brand loyalty. For example, Louisiana Pacific now controls 50% of the cellulose insulation market after its acquisition of GreenStone. It plans to have 15 manufacturing plants across the country and markets its product under the new "Cocoon" brand name. U.S. Plastic Lumber corporation is doing the same thing in recycled plastic lumber. Our challenge is to figure out what other product categories might lend themselves to this strategy.

Commercial / Institutional Green Building Sectors Overview

Building Delivery Mechanism

GB in commercial / institutional (and residential) sectors is about changing the approach to designing buildings - from linear to systems-based holistic approach - bring whole team together from the start - developer / owner / occupier / architect / engineer / building O&M people etc. Agree goals, targets etc.... and consider all systems together. Solve multiple problems simultaneously. Key Challenge = how to make buildings smarter and better at a lower cost.

Efficient and Smart Building coincides with "Green Building"

- GB is about using efficient technologies and materials, plus designing for the future .. designing the next generation of buildings, building in flexibility / and adaptability to accommodate future innovations, products. uses etc. ... look for demountable and flexible internal wall and lighting systems etc.

- Focus is on:

    - energy efficiency (reducing energy use - i.e. energy costs - by 50%)
    - ability to accommodate and use IT and "smart" technologies
    - flexibility in interior design - obsolesce in buildings doesn't derive from the shell or mass of buildings - but from the internal set up -- therefore the future is in modular internal systems. Need ability to move workers around quickly, easily and at low cost.
    - materials and systems to provide good IAQ - to lower absenteeism
    - good thermal and lighting comfort - to increase productivity and comfort
    - recycled-content materials - or those with lowest overall environmental impact.

- This is source of interest in 'products of service' - i.e. focus on providing the end-service - as in thermal comfort etc., and bundle products to provide service - lease them together - e.g. electricity / mechanical units / chilled water. Carrier, Enron, Pacificor already looking at this.

Owner-occupiers are primary drivers of (commercial) green building - over 100,000 sq. ft.

- Owner-occupiers constitute large corporations that build new HQs, office, manufacturing etc. facilities
- They are leading the charge in all GB

- New boom in corporate office building is widely predicted - driven by econ. growth and pent-up demand
- Have the most incentive - get to see long term benefit of operation and maintenance savings, as well as building value etc.
- Are seeing major savings in lower absenteeism etc.
- Law suits on IAQ also starting to make their mark
- Rides on general national preoccupation with quality of life issues ...
- GBs improve flexibility - reduce costs of moving staff around; many large companies have v. high 'turn rates' - some over 150% per year ... v. important factor - reduces costs and time of moves
- Companies in which staff productivity is v. important - retaining staff is important - e.g. software developers, etc., and companies that are themselves innovators
- they understand the systems approach - i.e. like car making now - fits with current trends in HR management thinking
- Have good $$ to invest
- Peer pressure among CEOs
- Employees are reporting v. favorably on GBs etc.
- Many new office buildings adopting target of operating on 50% less energy, being heavily daylit, looking for individual control over work-area thermal comfort
- Good for corporate PR - coverage in WSJ, Forbes, etc.

- In owner-occupied buildings, most important 'green' building aspects are IAQ and individually controlled thermal comfort and lighting. (driven by worker complaints - over 80% are about thermal comfort)

Typical GB - office - 30 year life cycle

Initial cost (land and building)	2%
O&M	6%
Personnel Costs	92%

=> achieving small gains in productivity / reducing absenteeism reaps by far the largest benefits for an owner-occupier (though not ness. the developer)
=> hence importance of IAQ, thermal comfort and lighting control

Institutional sector is secondary driver of large scale green building

- Green RPFs in many arms of Federal Government (Navy, Pentag... USPS, NOAA, EPA), forcing change in traditionally conservative contractors / suppliers

- Many state governments are specifying green buildings / 50% lower energy use etc., e.g. new CA State EPA building - 1 million sq. ft., $ 200 M
- Many municipalities now promote GB - Austin, Seattle, Portland, Santa Monica, San Diego, Tuscon etc. etc. - either mandatory or voluntary
- However - Govts. are ultimately constrained by tight budgets and procurement procedures that often require them to take lowest bidder and / or local providers .. green elements often go by the wayside
- David Gottfried predicts that this market is going to explode ... governments control lots of building, feel the pressure to 'serve' and respond to needs of public and communities

Overseas leaders

- **Swedish:** good on "House Techologies" - ? Nutek = state energy efficiency agency, quite active
- **Finns:** work a lot with the private sector - manufacturers, mainly residential applications. Have $20 million over 5 years for R&D of environmental building technologies, 2/3 of which goes to industry ....more than 100 companies looking at a wide variety of technologies. ABB is looking at 'low temp heating'; generally good at thermal insulation, windows, district heating systems
- **Dutch:** Advanced in lighting technologies - Philips. IAQ / material assessment work
- **Germany:** Franhoffer Institutes. Doing radiant colling technols. and HVAC products
- **Swiss:** are developing 'open building systems' ? - i.e v. flexible
- Europeans are generally good at integrating technologies
- Are several EC funded initiatives - demonstrating EE buildings

Investment Opportunities

None in distribution ...

Manufacturing	Developments	Services
1. Raised Flooring Systems	6. Haymount	3. Software:BISCIT
2. Strammit / straw core walls		8. GB Financing Co.
4. Solarwall		9. GB Auditing +
5. Modular Housing Factory		
	7. Urban Biosphere	

Plus there are many additional opportunities about which more information is needed.

Appendix H: Green Building Internet Sources

Green Building Resource Center

Web Links and Descriptions

@
www.geonetwork.org

Green Building Resource Center

Global Environmental Options (GEO)
and Building Concerns
are pleased to present this great little book of Web Links
from GEO's exciting new on-line Green Building Resource Center (GBRC).

The Green Building Resource Center is the most comprehensive green design and building resource currently available on the Internet. This book contains the Internet web sites available in the GBRC.

The new GBRC, which is continually expanding, already features 500 resources including case studies, books, research documents, specifications, professional contacts, and much more in one easily accessible location on the World Wide Web, providing invaluable information for designers, planners, architects, students and others interested in green building and sustainable building.

The Green Building Resource Center, developed by GEO in partnership with Building Concerns, is easy to use for both those professionals who have not previously used green concepts in their work, as well as those for whom the Internet has been a source of frustration rather than information.

Topics in the GBRC include: building design and systems, site development, plans and configuration, performance factors, construction processes, energy efficiency, indoor air quality, materials and products, maintenance requirements, waste management and water conservation.

The GBRC is one component of the larger GEO web site which contains a Link Library of hundreds of related web sites, a virtual bookstore, regional resource directories, news, calendars, hot topics and other services. The site also includes GEO's "Greening of the Parks" national program.

For more information about the Green Building Resource Center,
please contact Craig Hibberd at (801) 483-1635.

www.geonetwork.org/gbrc

LINKS BY TOPIC AREA

WHOLE SYSTEMS

Advanced Green Builder Demonstration Home
http://www.metropolismag.com/dec96/max.html

Aerogel: Energy-Efficient Material for Buildings
http://eande.lbl.gov/CBS/NEWSLETTER/NL8/Aerogel.html

Alternative Agricultural Research and Commercialization (AARC)
http://www.usda.gov/aarc

American Council for an Energy Efficient Economy (ACEEE)
http://solstice.crest.org/efficiency/aceee/index.htm

American Forests Global Releaf Program
http://www.amfor.org

American Institute of Architects
http://www.aia.org

American Solar Energy Society
http://www.sni.net/solar

American Wind Energy Association
http://www.igc.apc.org/awea

Arcosanti
http://www.arcosanti.org

Arizona Public Service Environmental Showcase House
http://www.asu.edu/caed/Herberger/ESH/TOC.html

ASHRAE
http://www.ashrae.org

Asset Based Community Development Institute
http://www.cpn.org/ABCDI/ABCDI.html

Association for Environment Conscious Building
http://members.aol.com/buildgreen/index.htm

Association of Professional Energy Managers
http://www.apem.org/index.htm

Audubon House: Building the Environmentally Responsible, Energy-Efficient Office
http://www.audubon.org

Brown is Green
http://www.brown.edu/Departments/Brown_Is_Green

Building A Solar Home in Maine
http://www.crest.org/renewables/wlord/index.html

Building Concerns Newsletter
http://www.interiorconcerns.org

Building Energy Analysis Group
http://eande.lbl.gov/EAP/BEA/bea.html

Building Energy Tools Directory
http://www.eren.doe.gov/buildings/tools_directory

Building Environmental Science and Technology
http://www.nrg-builder.com/greenbld.htm

California Materials Exchange (CALMAX)
http://www.ciwmb.ca.gov/mrt/calmax/calmax.htm

Canada Mortgage and Housing
cmhc-schl.gc.ca/publications/allabouthousing/cataloque.html

Center for Building Science
http://eande.lbl.gov/CBS/CBS.html

Center for Livable Communities/ Local Government Commission
http://www.lgc.org/clc

Center for Maximum Potential Building Systems (Maxpot)
http://www.maxpot.com

Center for Neighborhood Technol.
http://www.cnt.org

Center for Regenerative Studies, California State Polytechnic Univ.
http://www.csupomona.edu/landlab/regnstud.html

Center for Renewable Energy and Sustainable Technology - CREST
http://www.crest.org

Center for Resourceful Building Technology (CRBT)
http://www.montana.com/crbt

Center for Sustainable Cities
http://www.uky.edu/Classes/PS776/cscinfo.html

Center for Sustainable Communities - University of Washington
http://weber.u.washington.edu/~common

City of Austin Green Builder Program
http://www.greenbuilder.com/general/BuildingSources.html

City of Chattanooga
http://bertha.chattanooga.net/SUSTAIN

City of Seattle - Mayor's Recommended Comprehensive Plan
http://www.pan.ci.seattle.wa.us/seattle/planning/mayrintr.htm

Civano Online
http://www.civano.com

Clean Washington Center
http://www.cwc.org/

CNN Earth Network
http://www.cnn.com/EARTH/index.html

Colorado Plateau Forum
http://www.nbs.nau.edu/Forum

Community Eco-Design Network
http://www.tc.umn.edu/nlhome/m037/kurtdand/cen/

Community Environmental Council
http://www.grc.org

Computer-Based Design Tools - PowerDOE & Building Design Advisor (BDA)
http://eande.lbl.gov/CBS/NEWSLETTER/NL3/EDA.html

Consortium of Green Design and Manufacturing
http://euler.berkeley.edu/green/cgdm.html

Context Institute
http://www.context.org

Contractors Provide Major Influence on Sustainable Development
http://www.sellen.com/features/feature1.htm

CREST - Center for Renewable Energy and Sustainable Technology
http://crest.org

Design Exchange - Ecovillage
http://www.gaia.org/dx

Designing Low-Energy Building Guidelines - Energy 10 Software
http://www.psic.org/guidsoft.htm

Dewees Island
http://www.deweesisland.com

DOE - Energy Efficiency and Renewable Energy Network (EREN)
http://www.eren.doe.gov

DOE - Energy Information Admin.
http://www.eia.doe.gov

E Magazine
http://www.emagazine.com

E Source
http://www.esource.com

e-design Online
http://fcn.state.fl.us/fdi/e-design/online

E-Source Technology Atlas Series
http://www.esource.com

E2
http://www.e2digital.com

Earth Architecture Center International
http://www.unm.edu/~eaci

Eco-Home
http://www.ecohome.org

Eco-Village Information Service
http://www.gaia.org

EcoArch
http://pantheon.cis.yale.edu/~jluke313

EcoBuilding Schools: A Directory
http://www.ecodesign.org

EcoLiving Online
http://www.ecoliving.com

EDEN - Ecological Design Education Network
http://www.ecodesign.org/edi/eden/index.html

EE-Link, the Environmental Education Server
http://www.nceet.snre.umich.edu

Efficient House Sourcebook
http://www.rmi.org

Energy Design Tools - UCLA School of Architecture
http://www.aud.ucla.edu/energy-design-tools

Energy Efficient Housing in Canada
http://www.ualberta.ca/~amulder/house

Energy Home
http://www.energyhome.com

Energy Ideas Clearinghouse
http://www.energy.wsu.edu/ep/eic

Energy Ideas Clearinghouse - Software
http://www.energy.wsu.edu/ep/eic/eicsoft.htm

Envirocenter
http://www.envirocenter.org

Envirolink Network
http://www.envirolink.org

Environmental Building News
http://www.ebuild.com

Environmental Building News Calendar
http://www.ebuild.com/Current/Calendar.html

Environmental Protection Agency
http://www.epa.gov

EPA Green Lights Program
http://www.epa.gov/greenlights.html

EPA $mart Growth Network
http://www.sustainable.org/SGN/sgn_index.html

ERIN - Environment Resource Information Network
http://kaos.erin.gov.au/general/erin_info/info.html

Federal Energy Management Prog.
http://eande.lbl.gov/CBS/femp/femp.html

Findhorn Foundation's Ecological Village Project
http://www.gaia.org/findhorn

Florida Center for Environmental Studies
http://www.ces.fau.edu/homeg1.htm

Florida Interned Center for Understanding Sustainability
http://arch.usf.edu/ficus/default.htm

Florida Solar Energy Center (FSEC)
http://www.fsec.ucf.edu

Florida Solar Energy Center's Building Design Assistance Center (BDAC)
http://alpha.fsec.ucf.edu/~bdac

Forest Stewardship Council, The
http://www.goodwood.org/goodwood/goodwood_list/cert_agencies/fsc.html

Global Environmental Options
http://www.geonetwork.org

Global Recycling Network
http://www.grn.com/grn

Good Cents
http://www.goodcents.com

Good Wood Alliance
http://www.goodwood.org/goodwood

Greater Yellowstone Coalition
http://www.desktop.org/gyc

Green Building Design Projects
http://www.burthill.com/coe-grn.htm

Green Building Information Council (GBIC)
http://greenbuilding.ca

Green Building Resource Guide
http://www.greenguide.com/
home.htm

Green Clips
http://solstice.crest.org/environ-
ment/greenclips

Green Design Initiative
http://www.ce.cmu.edu/GreenDesign

Green Home for Washington, DC
http://greenhome.org/info.htm

Green Homes Gallery
http://www.ghm.com/GHM/GHoM-
Folder/HoM-Gallery.html

Green Map System
http://www.greenmap.com

Green Pages
http://www.eco-web.com

Greenbeat!
http://www.tec.org/greenbeat/
index.html

Greening of the White House
http://solstice.crest.org/environ-
ment/gotwh

Healthy House Institute
http:/www.hhinst.com

Healthy House - Toronto Canada
Mortgage and Housing Corporation
http://www.cmhc-schl.gc.ca/
HealthyHousing/Toronto/index.html

Holistic Options for Planet Earth
Sustainability
http://gladstone.uoregon.edu:80/
~hopes

Home Energy Costs
http://www.mcgi.com/saurus/
saurus.html

Home Power Magazine
http://www.homepower.com

ICLEI: Green Buildings Project
http://www.iclei.org/iclei/
gmbuild.html

Infinite Grid
http://www.metropolismag.com/
dec96/mixed.html

Interior Concerns Environmental
Resources
http://www.interiorconcerns.org

Internationale Nederlanden (ING)
Bank
www.rmi.org

Landlab, California State Polytechnic
University
http://www.csupomona.edu/landlab/
llhome.html

Lawrence Berkeley Laboratory -
Building Energy Analysis Group
http://eande.lbl.gov/EAP/BEA/
bea.html

Lawrence Berkeley National Labs -
Center for Building Science
http://eande.lbl.gov/BTP/BTP.html

Lighting Research Center
http://www.lrc.rpi.edu/Links

Logical Landscapes for Green Living
in Central Texas
http://www.greenbuilder.com/
general/articles/AAS.xeri.html

National Audubon Society
http://www.audubon.org

National Renewable Energy Laboratory - NREL
http://nrelinfo.nrel.gov

Natural Resources Defense Council
http://www.igc.org/nrdc/eamicus/clip01/eaoffice.html

Nautilus Institute for Security and Sustainable Development
http://www.nautilus.org

Neighborhood Reinvestment Corp.
http://www.nw.org/aboutnrc.htm

North Carolina Solar Center
http://www.ncsc.ncsu.edu

Northeast Sustainable Energy Association (NESEA)
http://www.crest.org/clients/nesea

Oikos: Green Construction Source
http://www.oikos.com

Pacific Adobe/TerraSystems
http://www.geocities.com/wallstreet/5643

Pacific Gas & Electric - Energy Center
http://www.pge.com/customer_services/other/pec

PAIRC - Planning & Architecture Internet Resource Center
http://www.arch.buffalo.edu/pairc

Passive Solar Industries Council - PSIC
http://www.psic.org

Public Technology, Inc. (PTI)
http://pti.nw.dc.us

R-2000 Homes Information Centre
http://www.aecinfo.com/r2000/index.html

Rainforest Action Network
http://www.ran.org

Real Goods Trading Corporation - Equipment
http://www.realgoods.com/main.html

Recycler's World
http://www.recycle.net/recycle/index.html

Renew America
http://solstice.crest.org/renew_america

Restorative Design
http://www.context.org/ICLIB/IC35/Berkebil.htm

Right of Salvage
http://www.buildingsmag.com/magazine/may_1996/article047.html

Rocky Mountain Institute
http://www.rmi.org

Saskatchewan Environmental Society
http://www.lights.com/ses

Solstice: Sustainable Living
http://solstice.crest.org/sustainable/index.html#Environment

Sun At Work in Europe On-line
http://www.demon.co.uk/tfc/sawie.html

SunWorld Magazine
http://www.demon.co.uk/tfc/sunworld.html

Sustainability and Construction Tech
http://www.saed.kent.edu/Architronic/v5n2/v5n2.02a.html

Sustainable Building Calendar
http://www2.greenbuilder.com/calendar/

Sustainable Building Sourcebook
http://www.greenbuilder.com/sourcebook

Sustainable Communities Information - Nova Scotia Env. & Devel. Coalition
http://www.cfn.cs.dal.ca/cfn/Environment/SCN/SCN_home.html

Sustainable Communities Resource Package (SRCP)
http://www.web.net/ortee/scrp

Sustainable Design Resource Guide for Colorado and the West Mt.
http://www.diac.com/~ggray/SDRG/sdrg.htm

Sustainable Development Institute
http://www.ibiic.com/sdi/sdi01.htm

Sustainable Minnesota
http://www.me3.org

Sustainable Sources
http://www.greenbuilder.com

Thoreau Center for Sustainability
http://www.thoreau.org/index.html

Trust for Public Land
http://www.tpl.org/tpl

United Nations - Best Practices
http://wheat.symgrp.com/habitat/html/index.html

Urban Ecology
http://www.best.com/~schmitty/ueindex.shtml

Urban Ecology Australia
http://www.eastend.com.au/~ecology/index.shtml

US Department of Energy (DOE) - Building Energy Tools Directory
http://www.eren.doe.gov/buildings/tools_directory

US Department of Energy (DOE) - Eneregy Efficiency and Renewable Energy Network
http://www.eren.doe.gov/EE/buildings.html

US Green Building Council
http://www.usgbc.org

Vital Signs Project
http://www.ced.berkeley.edu/cedr/vs

Warming Up to Solar
http://www.sustainable.doe.gov/articles/warming.html

Washington State Dept. of Ecology
http://www.wa.gov/ecology/ecyhome.html

Water Environment Web
http://www.wef.org

Whole House
http://www.energyhome.com

Woods of the World
http://www.woodweb.com/%7Etreetalk/home.html

Working with Light
http://www.context.org/ICLIB/IC35/Maret.htm

Yestermorrowp
http://www.madriver.com/ymorrow/Yestermorrow.htm

PRE-DESIGN

American Institute of Architects
http://www.aia.org

Arizona Public Service Environmental Showcase House
http://www.asu.edu/caed/Herberger/ESH/TOC.html

Audubon House
http://www.audubon.org

Building Environmental Science and Technology
http://www.nrg-builder.com/greenbld.htm

Energy Home
http://www.energyhome.com

Environmental Building News Calendar
http://www.ebuild.com/Current/Calendar.html

EPA Indoor Air Quality (IAQ)
http://www.epa.gov/iaq

EPA $mart Growth Network
http://www.sustainable.org/SGN/sgn_index.html

Federal Energy Management Program
http://eande.lbl.gov/CBS/femp/femp.html

Florida Solar Energy Center's Building Design Assistance Center (BDAC)
http://alpha.fsec.ucf.edu/~bdac

Forest Stewardship Council, The
http://www.goodwood.org/goodwood/goodwood_list/cert_agencies/fsc.html

Global Environmental Options
http://www.geonetwork.org

Good Cents
http://www.goodcents.com

Green Design Initiative
http://www.ce.cmu.edu/GreenDesign

Greening of the White House
http://solstice.crest.org/environment/gotwh

Industry Alliance for Interoperability
http://www.interoperability.com

Industry Alliance for Interoperability and Sustainable Design and Build
http://www.geonetwork.org/icernews/julaug96a.html#anchor466378

Internationale Nederlanden Bank
www.rmi.org

Logical Landscapes for Green Living in Central Texas
http://www.greenbuilder.com/general/articles/AAS.xeri.html

National Audubon Society
http://www.audubon.org

Rocky Mountain Institute
http://www.rmi.org

Sustainable Development Institute
http://www.ibiic.com/sdi/sdi01.htm

Thoreau Center for Sustainability
http://www.thoreau.org/index.html

Trust for Public Land
http://www.tpl.org/tpl

US Green Building Council
http://www.usgbc.org

SITE PLANNING

Arcosanti
http://www.arcosanti.org

Arizona Public Service Environmental Showcase House
http://www.asu.edu/caed/Herberger/ESH/TOC.html

Association for Environment Conscious Building
http://members.aol.com/buildgreen/index.htm

Building Environmental Science and Technology
http://www.nrg-builder.com/greenbld.htm

Center for Livable Communities/ Local Government Commission
http://www.lgc.org/clc

Center for Regenerative Studies, California State Polytechnic Univer.
http://www.csupomona.edu/landlab/regnstud.html

Center for Renewable Energy and Sustainable Technology - CREST
http://www.crest.org

City of Chattanooga
http://bertha.chattanooga.net/SUSTAIN

Designing Low-Energy Building Guidelines - Energy 10 Software
http://www.psic.org/guidsoft.htm

Dewees Island
http://www.deweesisland.com

Eco-Home
http://www.ecohome.org

Efficient House Sourcebook
http://www.rmi.org

Environmental Building News Calendar
http://www.ebuild.com/Current/Calendar.html

Environmental Protection Agency
http://www.epa.gov

Federal Energy Management Prog
http://eande.lbl.gov/CBS/femp/femp.html

Findhorn Foundation
http://www.gaia.org/findhorn

Florida Center for Environmental Studies
http://www.ces.fau.edu/homeg1.htm

Florida Interned Center for Understanding Sustainability
http://arch.usf.edu/ficus/default.htm

Greenbeat!
http://www.tec.org/greenbeat/index.html

Greening of the White House
http://solstice.crest.org/environment/gotwh

Healthy House - Toronto Canada Mortgage and Housing Corporation
http://www.cmhc-schl.gc.ca/HealthyHousing/Toronto/index.html

Internationale Nederlanden (ING) Bank
www.rmi.org

Landlab, California State Polytechnic
http://www.csupomona.edu/landlab/llhome.html

Logical Landscapes for Green Living in Central Texas
http://www.greenbuilder.com/general/articles/AAS.xeri.html

National Renewable Energy Lab.
http://nrelinfo.nrel.gov

Rocky Mountain Institute
http://www.rmi.org

Saskatchewan Environmental Society
http://www.lights.com/ses

Sustainable Building Sourcebook
http://www.greenbuilder.com/sourcebook

Sustainable Development Institute
http://www.ibiic.com/sdi/sdi01.htm

US. Department of Energy (DOE) Building Energy Tools Directory
http://www.eren.doe.gov/buildings/tools_directory

Warming Up to Solar
http://www.sustainable.doe.gov/articles/warming.html

Water Environment Web
http://www.wef.org

Worm Digest
http://www.WormDigest.org

BUILDING DESIGN

Advanced Green Builder Demonstration Home
http://www.metropolismag.com/dec96/max.html

Aerogel
http://eande.lbl.gov/CBS/NEWSLETTER/NL8/Aerogel.html

Aerosol-Based Duct Sealing Tech
http://eande.lbl.gov/CBS/NEWSLETTER/NL5/Duct.html

Alternative Agricultural Research and Commercialization (AARC)
http://www.usda.gov/aarc

American Forests Global Relief Prog
http://www.amfor.org

American Solar Energy Society
http://www.sni.net/solar

American Wind Energy Association
http://www.igc.apc.org/awea

Arcosanti
http://www.arcosanti.org

Arizona Public Service Environmental Showcase House
http://www.asu.edu/caed/Herberger/ESH/TOC.html

Association for Environment Conscious Building
http://members.aol.com/buildgreen/index.htm

Atlanta Summer Olympics - DOE - Energy Site
http://www.eren.doe.gov/olympics

Audubon House
http://www.audubon.org

Building A Solar Home in Maine
http://www.crest.org/renewables/wlord/index.html

Building Concerns Newsletter
http://www.interiorconcerns.org

Building Energy Tools Directory
http://www.eren.doe.gov/buildings/tools_directory

Building Environmental Science and Technology
http://www.nrg-builder.com/greenbld.htm

California Materials Exchange (CALMAX)
http://www.ciwmb.ca.gov/mrt/calmax/calmax.htm

Canada Mortgage and Housing
cmhc-schl.gc.ca/publications/allabouthousing/cataloque.html

Center for Building Science
http://eande.lbl.gov/CBS/CBS.html

Center for Maximum Potential Building Systems (Maxpot)
http://www.maxpot.com

Center for Regenerative Studies, California State Polytechnic Univ.
http://www.csupomona.edu/landlab/regnstud.html

Center for Renewable Energy and Sustainable Technology - CREST
http://www.crest.org

Center for Resourceful Building
http://www.montana.com/crbt

City of Austin Green Builder Prog.
http://www.greenbuilder.com/general/BuildingSources.html

Civano Online
http://www.civano.com

Clean Washington Center
http://www.cwc.org/

Community Eco-Design Network
http://www.tc.umn.edu/nlhome/m037/kurtdand/cen/

Computer-Based Design Tools - PowerDOE & Building Design
http://eande.lbl.gov/CBS/NEWSLETTER/NL3/EDA.html

Consortium of Green Design and Manufacturing
http://euler.berkeley.edu/green/cgdm.html

CREST - Center for Renewable Energy and Sustainable Technology
http://crest.org

Designing Low-Energy Building Guidelines - Energy 10 Software
http://www.psic.org/guidsoft.htm

Dewees Island
http://www.deweesisland.com

DOE - Energy Efficiency and Renewable Energy Network (EREN)
http://www.eren.doe.gov

DOE - Energy Information Administration
http://www.eia.doe.gov

E Magazine
http://www.emagazine.com

E-Source Technology Atlas Series, The
http://www.esource.com

E2
http://www.e2digital.com

Earth Architecture Center International
http://www.unm.edu/~eaci

Eco-Home
http://www.ecohome.org

EcoArch
http://pantheon.cis.yale.edu/~jluke313

EcoLiving Online
http://www.ecoliving.com

Ecological Architecture (Clearinghouse)
http://www.west.net/~prince

Efficient House Sourcebook
http://www.rmi.org

Energy Design Tools - UCLA School of Architecture
http://www.aud.ucla.edu/energy-design-tools

Energy Home
http://www.energyhome.com

Energy Ideas Clearinghouse
http://www.energy.wsu.edu/ep/eic

Envirocenter
http://www.envirocenter.org

Environmental Building News
http://www.ebuild.com

Environmental Building News Calendar
http://www.ebuild.com/Current/Calendar.html

Environmental Building News - Products
http://www.ebuild.com/Archives/Product_Reviews/ProductsList.html

Environmental Protection Agency
http://www.epa.gov

Envirosense Consortium
http://www.envirosense.org

EPA Green Lights Program
http://www.epa.gov/greenlights.html

EPA Indoor Air Quality (IAQ)
http://www.epa.gov/iaq

EPA $mart Growth Network
http://www.sustainable.org/SGN/sgn_index.html

Federal Energy Management Prog.
http://eande.lbl.gov/CBS/femp/femp.html

Findhorn Foundation
http://www.gaia.org/findhorn

Florida Solar Energy Center's Building Design Assistance Center
http://alpha.fsec.ucf.edu/~bdac

Forest Stewardship Council, The
http://www.goodwood.org/goodwood/goodwood_list/cert_agencies/fsc.html

Good Cents
http://www.goodcents.com

Good Wood Alliance
http://www.goodwood.org/goodwood

Green Building Resource Guide
http://www.greenguide.com/home.htm

Green Earth Office Supply
http://www.webcom.com/geos

Green Homes Galler
http://www.ghm.com/GHM/GHoM-Folder/HoM-Gallery.html

Green Pages
http://www.eco-web.com

Green Seal
http://www.greenseal.org

Green Spec: Specifications for Environmental Sustainability
http://www.spec-net.com/green.html

Greening of the White House
http://solstice.crest.org/environment/gotwh

Healthy House Institute
http:/www.hhinst.com

Healthy House
http://www.cmhc-schl.gc.ca/HealthyHousing/Toronto/index.html

Home Power Magazine
http://www.homepower.com

Homespun Fabrics & Draperies
http://www.homespunfabrics.com/~homespun

Indoor Environment Program
http://eande.lbl.gov/IEP/IEP.html

Infinite Grid
http://www.metropolismag.com/dec96/mixed.html

Interior Concerns Environmental
http://www.interiorconcerns.org

Internationale Nederlanden Bank
www.rmi.org

Lawrence Berkeley National Labs - Center for Building Science
http://eande.lbl.gov/BTP/BTP.html

Lighting Research Center
http://www.lrc.rpi.edu/Links

National Audubon Society
http://www.audubon.org

National Renewable Energy La
http://nrelinfo.nrel.gov

Natural Resources Defense Council
http://www.igc.org/nrdc/eamicus/
clip01/eaoffice.html

North Carolina Solar Center
http://www.ncsc.ncsu.edu

Northeast Sustainable Energy
Association
http://www.crest.org/clients/nesea

Oikos: Green Construction Source
http://www.oikos.com

Pacific Adobe/TerraSystems
http://www.geocities.com/wallstreet/
5643

Pacific Gas & Electric Energy Center
http://www.pge.com/
customer_services/other/pec

Passive Solar Industries Council
http://www.psic.org

R-2000 Homes Information Centre
http://www.aecinfo.com/r2000/
index.html

Rainforest Action Network
http://www.ran.org

Real Goods Trading Corporation
http://www.realgoods.com/main.html

Recycler's World
http://www.recycle.net/recycle/
index.html

REDI
http://www.oikos.com/redi/
index.html

Rocky Mountain Institute
http://www.rmi.org

Sun At Work in Europe On-line
http://www.demon.co.uk/tfc/
sawie.html

SunWorld Magazine
http://www.demon.co.uk/tfc/
sunworld.html

Sustainable Building Sourcebook
http://www.greenbuilder.com/
sourcebook

Sustainable Design and Construction
Database - National Park Service
http://www.nps.gov/dsc/dsgncnstr/
susdb

Sustainable Design Resource Guide
for the Colorado and the Western
Mountain Region, The
http://www.diac.com/~ggray/SDRG/
sdrg.htm

Sustainable Development Institute
http://www.ibiic.com/sdi/sdi01.htm

Thoreau Center for Sustainability
http://www.thoreau.org/index.html

US. Department of Energy (DOE)
Building Energy Tools Directory
http://www.eren.doe.gov/buildings/
tools_directory

Vital Signs Project
http://www.ced.berkeley.edu/cedr/vs

Warming Up to Solar
http://www.sustainable.doe.gov/articles/warming.html

Woods of the World
http://www.woodweb.com/%7Etreetalk/home.html

Working with Light
http://www.context.org/ICLIB/IC35/Maret.htm

CONSTRUCTION PROCESS

Arizona Public Service Environmental Showcase House
http://www.asu.edu/caed/Herberger/ESH/TOC.html

Association for Environment Conscious Building
http://members.aol.com/buildgreen/index.htm

Audubon House
http://www.audubon.org

California Materials Exchange (CALMAX)
http://www.ciwmb.ca.gov/mrt/calmax/calmax.htm

Center for Resourceful Building Technology (CRBT)
http://www.montana.com/crbt

City of Austin Green Builder Prog.
http://www.greenbuilder.com/general/BuildingSources.html

Clean Washington Center
http://www.cwc.org/

Contractors Provide Major Influence on Sustainable Development
http://www.sellen.com/features/feature1.htm

Dewees Island
http://www.deweesisland.com

E Magazine
http://www.emagazine.com

EcoLiving Online
http://www.ecoliving.com

Environmental Building News
http://www.ebuild.com

Environmental Protection Agency
http://www.epa.gov

Findhorn Foundation's Ecological Village Project
http://www.gaia.org/findhorn

Global Recycling Network
http://www.grn.com/grn

Green Home for Washington, DC (Habitat for Humanity)
http://greenhome.org/info.htm

Healthy House - Toronto Canada Mortgage and Housing Corporation
http://www.cmhc-schl.gc.ca/HealthyHousing/Toronto/index.html

Landlab, California State Polytechnic University
http://www.csupomona.edu/landlab/llhome.html

National Audubon Society
http://www.audubon.org

Natural Resources Defense Council
http://www.igc.org/nrdc/eamicus/clip01/eaoffice.html

Rocky Mountain Institute
http://www.rmi.org

Sustainable Building Sourcebook
http://www.greenbuilder.com/sourcebook

Thoreau Center for Sustainability
http://www.thoreau.org/index.html

BUILDING MANAGEMENT, OPERATIONS & MAINTENANCE

Association for Environment Conscious Building
http://members.aol.com/buildgreen/index.htm

Audubon House: Building the Environmentally Responsible, Energy-Efficient Office
http://www.audubon.org

Building Energy Tools Directory
http://www.eren.doe.gov/buildings/tools_directory

Canada Mortgage and Housing
cmhc-schl.gc.ca/publications/allabouthousing/cataloque.html

Clean Washington Center
http://www.cwc.org/

Designing Low-Energy Building Guidelines - Energy 10 Software
http://www.psic.org/guidsoft.htm

e-design Online
http://fcn.state.fl.us/fdi/e-design/online

EcoLiving Online
http://www.ecoliving.com

Energy Home
http://www.energyhome.com

Environmental Protection Agency
http://www.epa.gov

EPA Indoor Air Quality (IAQ)
http://www.epa.gov/iaq

Green Building Information Council
http://greenbuilding.ca

Lawrence Berkeley Laboratory - Building Energy Analysis Group
http://eande.lbl.gov/EAP/BEA/bea.html

National Audubon Society
http://www.audubon.org

Natural Resources Defense Council
http://www.igc.org/nrdc/eamicus/clip01/eaoffice.html

Pacific Rim Consortium in Energy, Combustion & Environment
http://parcon.eng.uci.edu

Vital Signs Project
http://www.ced.berkeley.edu/cedr/vs