

LEED HOMES  
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Conforming to the required standard

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## **Abstract**

This report on LEED homes identifies the driving forces behind green building and the underlying concept of sustainability. An introduction to the green consumer is detailed and the market segment which the green consumer belongs to is defined. A brief history and overview of other LEED standards highlights the similarities between them and these other standards offers data that can be used to indicate future trends. This housing and building trend data is then put together to show the increasing market demand for products such as LEED for Homes.

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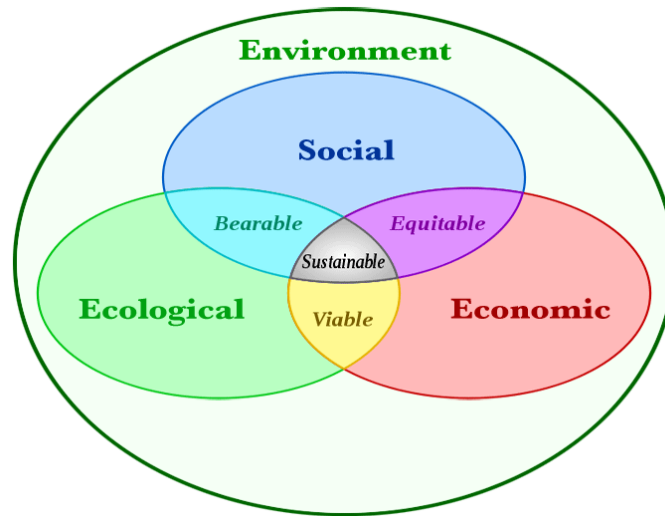
## Introduction

Understanding what is “Green” and what is not has become more complex since our world has become increasingly aware of environmental issues; climate change, pollution, and unsustainable lifestyles. It seems that we are constantly bombarded with different information about what is considered to be environmentally responsible. This information is being delivered on the local, regional, national and international levels to address these issues of over consumption and pollution. In addition to information being delivered at different levels, it is also delivered from a variety of different sources such as individual consumers, government policies, corporations, and third party organizations that certify products.

For example, to encourage better recycling habits on the local level in Vancouver, there are trash cans on the street corners that have spaces for bottles to be left so that they can be recycled and not just thrown away. On the regional level, there is the British Columbia Recycling Counsel that promotes a Zero Waste Initiative and International effort can be seen in the United Nations Framework Convention on Climate Change which produced the Kyoto Protocol. What all these examples have in common is that the concept on which they all focus is sustainability. Sustainability being defined as

*“An economic, social, and environmental concept that involves meeting the needs of the present without compromising the ability of future generations to meet their own needs.” (CMHC)*

Figure 1



(Source: Wikipedia)

With this definition in mind there has been a demand from the building market and an initiative within the building sector to better design and engineer buildings to be more sustainable, more “Green”. One of the major organizations behind developing a standard that represents “Green Building” is the United States Green Building Council or USGBC. The USGBC has developed a program called Leadership in Energy and Environmental Design or LEED. LEED has many different standards that range from planning entire new communities, new construction, existing buildings, retail interiors, schools and homes. The LEED standards are a specific set of written requirements that are outlined in detail and are authenticated by an inspector, who awards points to contribute to a certification. Depending on the number of points awarded, LEED will identify the project Certified, Silver, Gold, and Platinum. Since the success of the USGBC in the US building market there has also recently been the creation of the Canadian Green Building Council (CaGBC). The CaGBC uses the same standards as USGBC and is essentially an extension of the USGBC in Canada. This is because the

councils are made up of chapters. In fact, there is actually a regional green building chapter called Cascadia that includes both States and Provinces from the Pacific Northwest which functions internationally. So, for the purposes of this report the USGBC and CaGBC should be considered as interchangeable.

Originally, LEED certification was geared toward the institutional and commercial buildings because of a partnership that it developed with the General Service Administration (GSA) which will be discussed in detail in the report. The GSA starting in 2003 mandated that federal buildings in the United States were to be built in accordance with LEED standards. Recently though, the USGBC published a standard for the residential building sector called LEED for Homes. LEED for Homes is the USGBC standard specifically for the building and renovation of residential homes in North America and will be the focus of this report.

## **The Green Consumer**

Understanding what drives demand for sustainable products is fundamental in making the business case for sustainable building. There have been many studies on the trends, demographics, psychographics of consumers who prefer more sustainable products. An article in the Journal of Consume Marketing; Environmental Segmentation Alternatives: A Look at Green Consumer Behavior in the New Millennium by Robert Strauhan and James Roberts, from Baylor University references over 35 independent studies on sustainability related segmentation. Perhaps one of the most well known breakdown of the sustainable consumer was done by the Natural Marketing Institute (NMI).



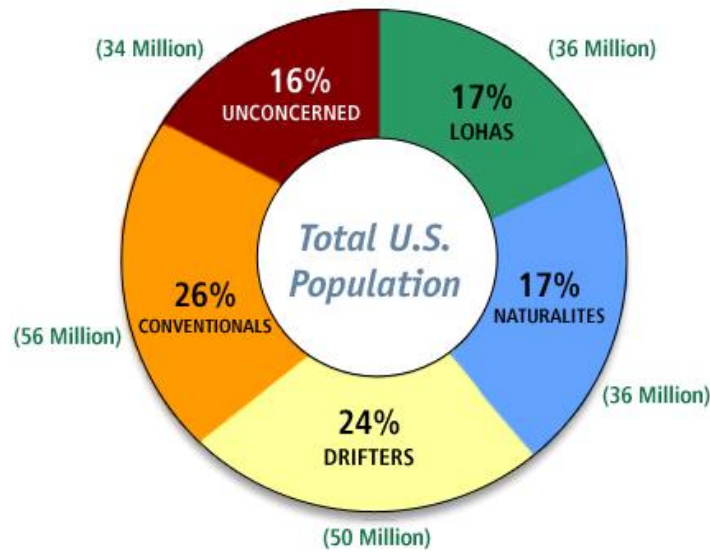
The NMI created the well known LOHAS consumer segmentation model. LOHAS is an acronym for Lifestyles of Health and Sustainability. The difference between LOHAS and conventional marketing segmentation models is that LOHAS uses consumer values to segment the market as opposed to the traditional demographic profiling, which will be discussed after the LOHAS model. The LOHAS model is based on an annual sample of 7 million consumers that are representative of the US adult population with a 95% confidence level (Methodology-NMI website). The LOHAS model classifies the population by dividing the population into 5 mutually exclusive categories. By having each category mutually exclusive according to their behavior, consumers can be identified with regard to what they would purchase a particular green product. The five segments and the associated behaviors are listed in Table 1.

**Table 1**

<b>SEGMENT</b>	<b>BEHAVIORS &amp; ATTITUDES</b>
LOHAS	<ul style="list-style-type: none"> <li>• Make environmentally friendly purchases</li> <li>• Dedicated to personal &amp; planetary health</li> <li>• Support advocacy programs</li> </ul>
NATURALITES	<ul style="list-style-type: none"> <li>• More health focused</li> <li>• Tend to eat natural or organic products</li> <li>• Not politically involved in the environment</li> </ul>
DRIFTERS	<ul style="list-style-type: none"> <li>• Purchasing determined more by price and trends than environmental merit</li> </ul>
CONVENTIONALS	<ul style="list-style-type: none"> <li>• Are involved in environmental stewardship on municipal level</li> <li>• No strong environmental attitudes</li> </ul>
UNCONCERNED	<ul style="list-style-type: none"> <li>• Generally disregard responsible environmental behavior</li> </ul>

Figure 2 is taken from the NMI website and breaks down the US population into their appropriate consumer segment.

Figure 2



Source: NMI website

According to NMI there are 36 million consumers that represent 209 billion in spending (LOHAS website) in the US. This is who actively purchase green products like LEED certified homes. The LOHAS market segment even have a website dedicated to pursuing LOHAS values. They also publish a LOHAS Journal and have LOHAS news. On the news page of the website there was a link to an article which stated “Photovoltaic Solar Installations are up 110% in 2008”. These photovoltaic solar systems would be the same type of product that if installed in a LEED home would be worth a possible 10 points.

Demographic Segmentation for the green consumer is not nearly as effective according to the actual Green Consumer Behavior in the New Millennium in the Journal of Consumer Marketing. The study of 235 university students yielded the following results.

**Table 2**

Regression of Ecological Consumer Consumption Behavior with Demographic Variables		
VARIABLE	R <sup>2</sup> COEFFECENT	SIGNIFIENCE
Constant	72.846	<0.001
Age	1.366	0.004
Classification	-7.306	0.002
Income	-0.505	0.300
Sex	5.998	0.033
Notes: R <sup>2</sup> = 0.087, F = 4.881, df = 4, 204		

Source: Green Consumer Behavior in the New Millennium in the Journal of Consumer Marketing

These results are not conclusive but later in the report there is a reference to the typical demographic profile of the green consumer which is a “Young, mid- to high-income level, educated, urban woman”. That being said, there was also a comparison done between the R<sup>2</sup> of the value segmentation model which showed a R<sup>2</sup> value of 0.393 which is more than four times the R<sup>2</sup> of demographic segmentation. In the LOHAS segmentation model both types of analysis are combined and result in a better model than demographic segmentation.

## **Relationship between LEED and Government**

Originally, LEED certification was geared toward institutional and commercial buildings and was very well suited to provide a standard that could be used to satisfy Executive Order 13123, Greening the Government Through Efficient Energy Management. The order made the General Services Agency (GSA) of the US government responsible for meeting the goals laid out in Part 2, sec 201 - section 207, of Executive Order 13123.

As a result, starting at the beginning of the 2003 fiscal year, GSA mandated A LEED rating level of “Certified” for all new design starts, with a target of a LEED “Silver rating.”

## **Brief history of USGBC LEED**

In 1994 a scientist named Robert Watson was a senior scientist working with National Resources Defense Council (NRDC) (it is a non profit, environmental nongovernmental organization that was lobbying for government policies that favor environmental stewardship.) Robert Watson was the founding chairman of the LEED Steering Committee until 2006. The LEED steering committee is comprised of a broad-based consensus process which includes non-profit organizations, government agencies, architects, engineers, developers, builders, suppliers, and industry leaders. Some other LEED committee members that were responsible for LEED’s development are USGBC co-founder Mike Italiano, architects Bill Reed and Sandy Mendler, builder Gerard Heiber and engineer Richard Bourne. As LEED grew there was the need to form a technical committee which was formed in 1996 by engineers Tom Paladino and Lynn Barker. Since then LEED has grown from its original six member committee to over 200 volunteers on 20 committees with three dozen professional staff.

LEED originally started with the development of a single standard for new construction in 1996 to set of eight different standards that will be elaborated on in the following section. The different Standards are:

- |  |                                 |
|--|---------------------------------|
| 1. New Construction                                  | 5. Schools                      |
| 2. Existing Buildings-<br>Operations and Maintenance | 6. Healthcare                   |
| 3. Commercial Interiors                              | 7. Homes                        |
| 4. Core and Shell                                    | 8. Neighborhood<br>Developments |

## **LEED for Homes**

Although USGBC and LEED have been around more than 10 years, LEED for Homes version 1.0 was just released in March of 2009. In order to give a better understanding of what developments took place in USGBC, that are responsible for the original LEED standards. It is important to be aware of these other standards in order to be able to draw on research done in there respective types of construction. Construction of homes has many identical traits as different types of construction only the scale is smaller. It would be a close representation of the costs and trends likely to be seen in the residential building sector. It is not a perfect representation but it would seem to be the natural place to extract data because of length of time LEED for New Construction has been around and the there information published about it.

## **Other LEED Standards**

The USGBC developed the nine different LEED standards in order to address the issues of sustainability holistically from a North American building perspective. They also have incorporated the retro fitting of old developments into more sustainable buildings. The following is a list of LEED Standards used and an example of that type of project might be.

### **1. New Construction**

This standard is for new construction and major renovations of major commercial and institutional buildings.

## **2. Existing Buildings (Operations and Maintenance)**

This standard focuses on the running of the building and includes waste management systems and recycling programs and chemicals used for cleaning.

## **3. Commercial Interiors**

This Standard focuses on tenant improvement market for project that are leased or rented. This is important because an individual tenant would not have control over an entire building. The standard emphasizes high performance green interiors, a healthy work environment and reducing the overall environmental footprint .

## **4. Core and Shell**

This Standard is meant to complement the Commercial Interiors Standard and focus structure and heating ventilation and air conditioning systems so that together with the tenants occupying the space there is collaboration to create sustainable work environments.

## **5. Schools**

This Standard is essentially the same as the New Construction Standard with special attention given to designing for classroom acoustics, cost effectiveness and comfort for both student and teachers.

## **6. Healthcare**

This standard focuses again on all the same sustainability attributes but with special attention to things such as location of parking facilities, proximity to chemicals and pollutants.

## **8. Neighborhood Developments (currently in pilot tabled to launch in summer 2009)**

The standard focuses on the a high standard of site selection and smart grown through thorough planning.

## **LEED for Homes Goals and Strategies**

Examining the LEED mission statement and examining the requirements for meeting their certification show how LEED is establishing what a sustainable home should be.

### **LEED's Mission**

*“To transform the way buildings and communities are designed, built and operated, enabling an environmentally and socially responsible, healthy, and prosperous environment that improves the quality of life”*

The LEED mission statement's goals are to address the three main dimensions of sustainability; economic, social, and ecological dimensions. Some of the strategies that LEED has used to address the different dimensions of being sustainable are outlined below and which aspect of sustainability they address.

## **Ecological**

To address ecological and environmental issues LEED approaches them from the different stages of a project life cycle. In the design/conception stage of a project, LEED encourages that each project has a project team and that goals for what level of certification desired is in order for the appropriate measures can be taken in the designing and planning of the project. Integrated Design Process and Durability Planning is worth a possible seven points when applying for certification.

The in-use phase stage of a LEED home address requiring homes to have a minimum EnergyStar Home Energy Requirement Sysytem or HERS of 80 as a requirement. This means that as a requirement any home LEED certifies will be at least 20% more efficient than a standard home based on the International Energy Conservation Code or IECC.

## **Economic**

The way that LEED address the economic issues is to put an emphasis on reducing energy consumption in the use phase of the buildings life cycle. This offsets any increased up front costs of building to a LEED standard, and over a building's life cycle better energy efficiency end up saving on energy costs, and waste costs.



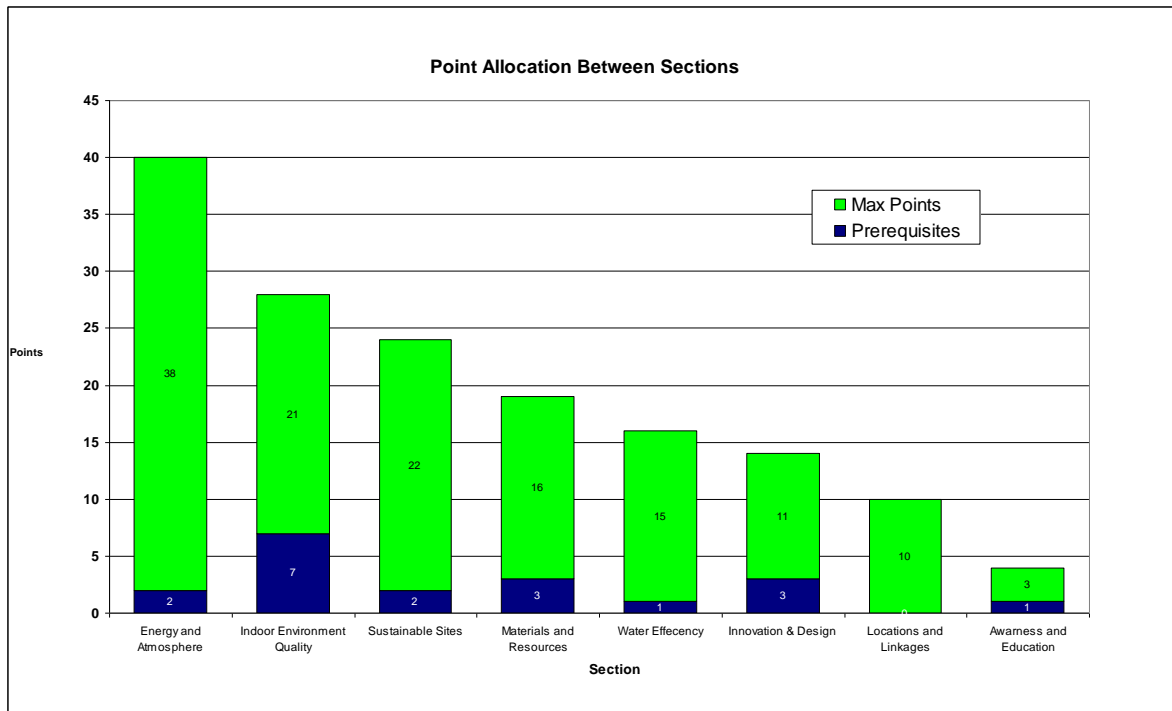
There is also a section of the LEED for Homes standard that awards points for home owner education and awareness this includes a maintenance plan that provide savings through increased performance of a home.

## Social

LEED for Homes addresses health and safety needs in the Indoor environmental quality section which addresses the need for indoor air to be free of mold and toxic gases like carbon monoxide by incorporating exhaust systems that filter air and have minimum safety requirements.

Figure 3 below breaks down the LEED for Homes standard by the number of points allocated to each section and showing them as a percent of total possible points.

Figure 3



**Energy use and Efficiency** is the most heavily weighted section and would by number of points be the most important attribute in the point scheme. This would be appropriate because buildings account for 36% of total energy use, 65% of electricity consumption, 30% of greenhouse gas emissions annually in the United States (U.S. DOE Energy Information Administration). The more LEED projects certified and operating using these standards will result in more sustainable energy consumption patterns; in turn this will result in lower operating costs for the project owner, and these savings can justify increased up front capital costs of certification.

**Indoor environmental quality** as number two in the allocation of points reflects the value of a healthy and safe environment. This is accomplished by installing moisture control equipment that can prevent mold growth as well as conducting tests for back draft potential. There are a large portion of prerequisite points required for this section

**Materials and Resources** ranks among the top of these attributes and addresses sustainability at the extraction level by requiring FSC certified wood products and requires higher standards from supplies in turn creating a cascading effect increasing demand for sustainable utilities and building materials.

**Water efficiency** is another characteristic ranked heavily, by managing consumption and reusing gray water a LEED certified home reduces demands on water infrastructure and limited water resources.

## **Why has LEED ventured into Homes**

The USGBC and the CaGBC have made the move into the Home segment of the building sector because of the natural progression of the LEED certification process due to external forces like increase consumer demand for green products by the LOHAS market segment. The progression of the LEED process is a result of increased general awareness of sustainability issues and their causes and the progression of LEED popularity as a function of time. There is no real magic to its success. It has been successful because it uses sound principals and logical consensus to approach problem solving. This has resulted in standards that are achievable, given the current state of the building sector.

## **The LEED for Homes rating system**

The LEED rating system incorporated many measures that were established by other Standards Organizations like the Canadian Standards Association (CSA) and ENERGY STAR. The CSA manages over a hundred Technical Committees that contribute to their construction program. The construction program has standards for National Construction Codes, Building Products and Systems, Plumbing Products and Materials, Structures, and Forest Products. ENERGY STAR is a joint program of the U.S. Environmental Protection Agency and the U.S. Department of Energy. ENERGY STAR rates products and then applies there logo if their product meets ENERGY STAR requirements. They rate appliances, heating and cooling equipment, water heaters, windows, lighting and home electronics. Most of their measures come from the International Energy Conservation Code (IECC) that was published in 2004. LEED for

Homes uses many of rating systems designed by other organizations but with a minimum level or rating to achieve points.

The LEED for Homes rating system is broken down into eight different sections that address different facets of home design and construction. The following is a breakdown of the different sections and a brief summary of what that section entails and what type of measures are used in determining the number of points to be awarded. A sample of the actual credit requirements from LEED for Homes standard will be included in the appendix.

**Table 3**

<b>SECTION COMPONENTS</b>	<b>MEASURES</b>
<b>Energy and Atmosphere</b>	
<ol style="list-style-type: none"> <li>1. HVAC system –Heating, Ventilation, and Air Conditioning</li> <li>2. Insulation and heating systems</li> <li>3. Windows, doors, water heating, and lighting</li> <li>4. Appliances</li> </ol>	<ol style="list-style-type: none"> <li>1. ENERGY STAR HERS index or EnerGuide HRS index.</li> <li>2. ENERGY STAR Thermal bypass inspection checklist.</li> <li>3. R values from 2004 IECC. ENERGY STAR certified or CSA ER rating</li> </ol>
<b>Materials and Resources</b>	
<ol style="list-style-type: none"> <li>1. Detailed framing documents</li> <li>2. Prefabricated assemblies, taking advantage of manufacturing efficiencies</li> <li>3. Sustainable sources</li> </ol>	<ol style="list-style-type: none"> <li>1. Waste as percent of framing lengths and distance between studs</li> <li>2. Detailed cut list and Lumber order</li> <li>3. FSC certified lumber</li> </ol>
<b>Water Efficiency</b>	
<ol style="list-style-type: none"> <li>1. Water Reuse (rain water and graywater)</li> <li>2. High efficiency fixtures</li> <li>3. Minimizing the amount of potable water consumed</li> </ol>	<ol style="list-style-type: none"> <li>1. Area or roof dedicated in percent to harvest/store rain water, liters per year</li> <li>2. Flow rate (L / M)</li> <li>3. Reduction as percent</li> </ol>
<b>Indoor Environment Quality</b>	
<ol style="list-style-type: none"> <li>1. Local exhaust</li> <li>2. Air filtering</li> <li>3. Moisture Control</li> <li>4. Distribution of space heating and cooling</li> </ol>	<ol style="list-style-type: none"> <li>1. Minimum air flow (m<sup>3</sup>/ min)</li> <li>2. Minimum Efficiency Reporting Value filters MERV value</li> <li>3. Active dehumidification equipment present</li> <li>4. Third party inspection CSA F280 standard</li> </ol>

<b>Sustainable Site Selection</b>	
<ol style="list-style-type: none"> <li>1. Erosion control</li> <li>2. Non-toxic pest control</li> <li>3. Compact development</li> </ol>	<ol style="list-style-type: none"> <li>1. Site specific measures</li> <li>2. Site specific measures</li> <li>3. Lot size &lt; 0.06 hectare</li> </ol>
<b>Awareness and Education</b>	
<ol style="list-style-type: none"> <li>1. Educating owner on local recycling programs</li> </ol>	<ol style="list-style-type: none"> <li>1. Location specific plans submitted for review by LEED inspector</li> </ol>
<b>Locations and Linkages</b>	
<ol style="list-style-type: none"> <li>1. Site selection location</li> <li>2. Community resources and public transit</li> </ol>	<ol style="list-style-type: none"> <li>1. Proximity to wetland, flood plain, protected ecosystem in meters</li> <li>2. Proximity to Bank, post office, school, bus stop, ect</li> </ol>
<b>Innovation &amp; Design</b>	
<ol style="list-style-type: none"> <li>1. Integrated project planning, build for salvage</li> <li>2. New innovations</li> </ol>	<ol style="list-style-type: none"> <li>1. Durability risk evaluation form checklist</li> <li>2. Proposed with innovation</li> </ol>

Table 3

**Energy and Atmosphere** is the most important attribute in their point scheme. This would be appropriate because buildings account for 36% of total energy use, 65% of electricity consumption, 30% greenhouse gas emissions annually in the United States (U.S. DOE Energy Information Administration). The more LEED projects certified and operating using these standards will result in more sustainable energy consumption patterns; in turn this will result in lower operating costs for the project owner, and these savings can justify increased up front capital costs.

**Indoor Environment Quality** is especially important to Canadians because on average we spend 90 percent of your time indoors (Health Canada). So by reducing indoor air pollutants like pollen, toxic off-gasing, and carbon monoxide, will have significant health benefits.

**Sustainable Sites** has an emphasis on building on previously developed land to conserve undeveloped land and use fewer resources to connect to existing infrastructure.

**Materials and Resources** ranks among the top of these attributes and addresses sustainability at the extraction level and requires higher standards from suppliers in turn creating a cascading effect increasing demand for sustainable utilities and building materials.

**Water efficiency** is achieved by managing possible pollutants and reusing waste water reduces demands on water infrastructure and limited water resources.

**Innovation and design** encourages sustainability by incorporating points into the LEED points system that are earned by improving on any of the other categories. There is a lot of freedom as long proposed innovations are sustainable and measurable.

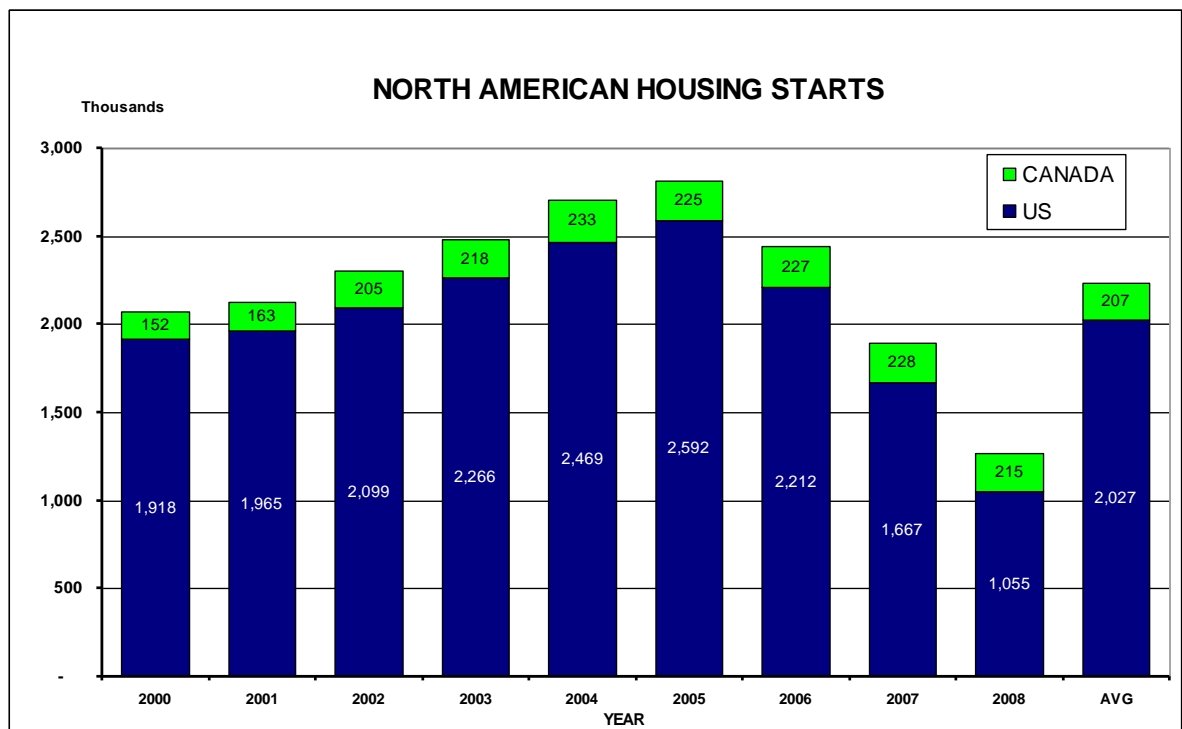
**Location and Linkages** promotes sustainability by incorporating close proximity to public transit and services encouraging less driving and in turn less green house gas emissions.

**Awareness and Education** is essential to the success of any programs success and is vital when trying to live sustainable lifestyle.

## **Housing Market Size and Industry trends**

In order to understand what the market size for LEED for Homes certification is and the trends that can be expected in this market. In order to understand the size of the market housing starts statistics will be examined as well as trends in other building sectors that have LEED standards. Examining the number of starts and then comparing the trends seen in other LEED certification in other building sectors. Then extrapolating those trends to the number of housing starts may give some insights into what the future may hold for LEED for Homes. Figure 4 below shows the number of housing starts in North America. Figure 5 shows growth in square feet of LEED certified space. In Figure 7 the two sets of data are combined with some simple assumptions and the result in an estimate of the expected growth in certified of homes in North America.

**Figure 4**



Source: US Census Bureau & CHMC

The number of housing starts has been declining due to the recent credit crunch so when calculating the possible growth an average of 2,234,550 starts will be used.

Figure 5



Note: The total LEED - certified area has been growing at about a 50% compounded growth rate since 2000 (RREEFF Research).

Figure 6

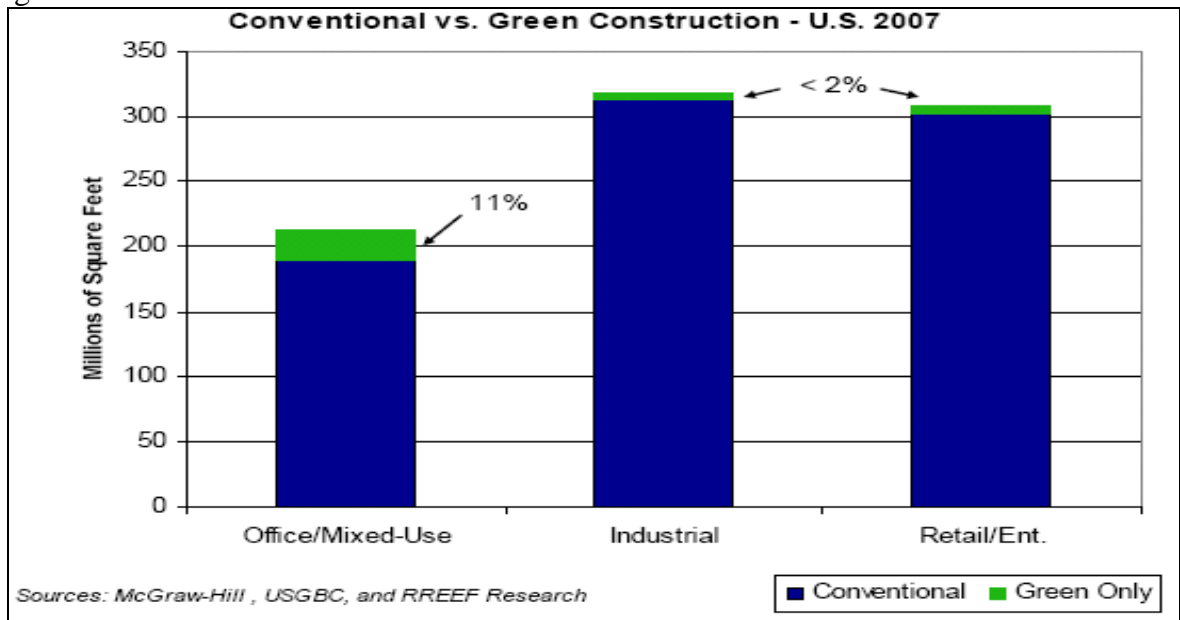


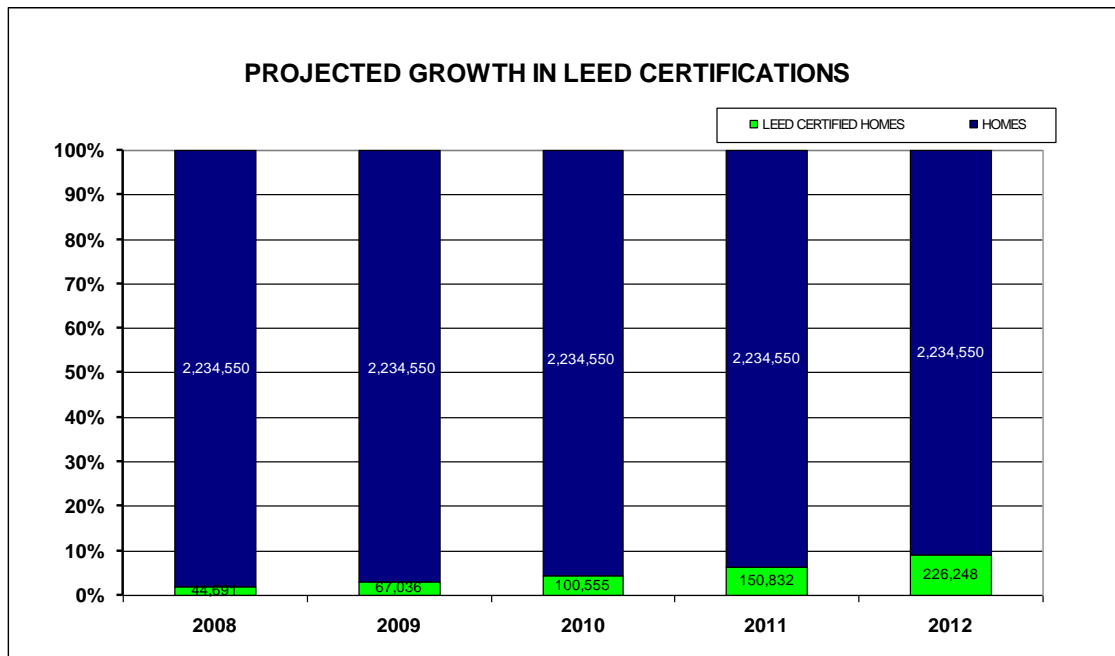


Figure 6 is very important because it highlights that despite the large growth in LEED certification the proportion of Green construction Vs. convention construction is relatively small.

If we take a conservative approach to the estimates of growth, assuming:

- (2000-2008)Average number of starts of
- Average number of starts stays constant 2,234,550
- 2% of starts will be certified
- Annual growth of 50%
- 5 year projection

Figure 7



With housing starts declining and an unambiguous increase in certifications there is a trend towards building more sustainable homes in North America. However this

trend in only a small proportion of the housing market when compared to the overall market of homes. There are clear indications that if current trends continue there will be significant increases in demand for both LEED homes and LEED professionals and the products they produce.

## **Summary**

As North American consumers continue to become more aware of sustainability issues and as growing number of sustainable products become mainstream, there will be a increase in the market segmentation to LOHAS from Conventionals . As LOHAS segment of consumers continues to grow standards like LEED for homes will become increasingly important as a means to establish minimum requirements. LEED can serve to verify with confidence that LEED home is a green home. The trends in building sectors showing 50% year over year growth clearly reiterate that there will be increases demand in the future for LEED for Homes. LEED for homes takes the overwhelming amount of “green” information published and offers consumers a clear and concise set of measures that will allow the consumer to play a larger roll in North American, and global sustainability movement.

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ID	LL	SS	WE	<b>EA</b>	MR	EQ	AE
<b>Credit 2</b>							

2 Points

# Energy & Atmosphere

## Insulation

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### Intent

Design and install insulation to minimize heat transfer and thermal bridging.

### Requirements

#### Prerequisites

**2.1 Basic Insulation.** Meet all the following requirements:

- a) Install insulation that meets or exceeds the R-value requirements listed in Chapter 6 of the 2004 International Energy Conservation Code (Table 602.1) or the local building codes, whichever is more stringent. Alternative wall and insulation systems, such as structural insulated panels (SIPs) and insulated concrete forms (ICFs), must demonstrate a comparable R-value, but thermal mass or infiltration effects cannot be included in the R-value calculation.
- b) Install insulation to meet the provincial or local standards. Installation must be verified by a Green Rater conducting a pre-drywall thermal bypass inspection, as summarized in Figure 3.

#### Credits

**2.2 Enhanced Insulation** (2 points). Meet the following requirements:

- a) Install insulation that exceeds the R-value requirements listed in Chapter 6 of the 2004 International Energy Conservation Code (Table 602.1) or the local building code, whichever is more stringent, by at least 20%. Alternative wall and insulation systems, such as structural insulated panels (SIPs) and insulated concrete forms (ICFs), must demonstrate a comparable R-value, but thermal mass or infiltration effects cannot be included in the R-value calculation.
- b) Install insulation to meet grade I standards. Installation must be verified by a Green Rater conducting a pre-drywall thermal bypass inspection, as summarized in Figure 3.