Revisiting the Green Tragedy

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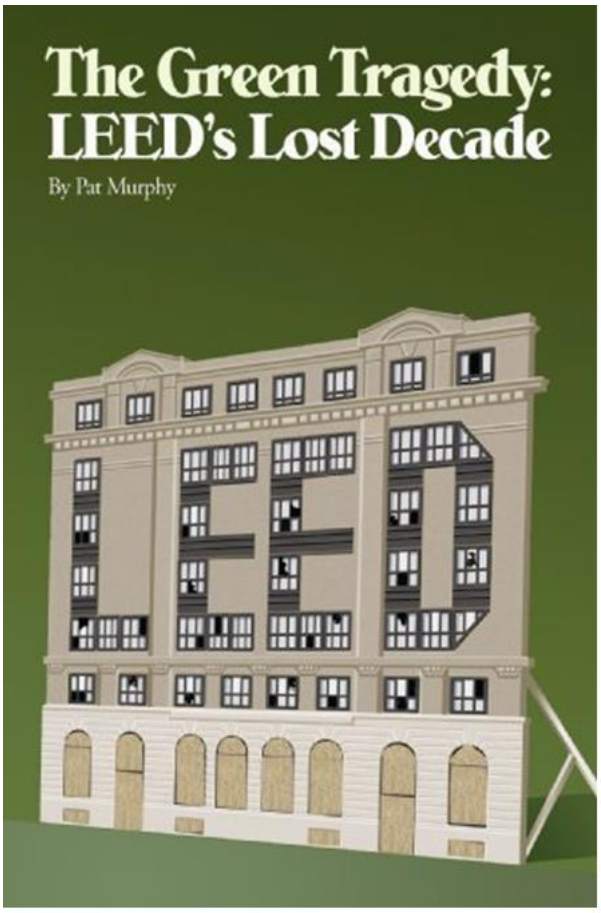

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Introduction

In 2009 I self-published *The Green Tragedy – LEEDS lost decade,* a small 75 page book.[1] LEED stands for Leadership in Energy and Environment; it is the best known "green" building rating system in the country. LEED was developed by the US Green Building Council (USGBC), which provides updates and maintains the standard. My intention in writing the book was to point out that so called "green building," as understood at that time, did not sufficiently emphasize energy savings and thus cannot achieve major reductions in building CO_2 emissions.

A series of articles about green building and LEED written in early 2015 led me to review the book to see if there is new data to substantiate or challenge its hypothesis. The articles revolved around a series of interviews, discussions, and letters concerning Jerry Yudelsen, a well-known green building author, who was an early contributor to the LEED program and a major educator of LEED-AP students. Yudelsen spent 15 years advocating for LEED. In December 2013 he became president of LEED's main competitor Green Globes.

In February 2015, Yudelsen wrote an article *Why green building has hit the wall and what to do about it* which included the following key statistics: [2]

1. Green commercial building activity has peaked in the U.S. at about 4,500-5,000 projects per year, as measured by LEED, Green Globes and Living Building Challenge projects.
2. LEED has certified less than 0.5% of the U.S. commercial building stock of 5 million buildings in 15 years (about 25,000 buildings) and measured by area – less than 3% of the 85 billion square feet of commercial building space. LEED began certifying commercial buildings in 1998

Yudelsen asked the rhetorical question of how to "scale" the impact of green building in light of growing concerns about climate change, water scarcity, and other concerns. He said the pressing question is: "Why hasn't the current system had more marketplace success?" and noted the areas of LEED impacts (large commercial offices, high profile areas) and those areas where it has had little impact (small offices, K-12 schools, retail stores). He suggested that the key answer is that "Perceived benefits do not measure up to actual costs." He also confirmed the difficulty of selling green building certification to the person who "signs the front of the check."

Of great significance is another Yudelsen statement "… the benefits include savings in energy efficiency that would be achieved in most cases without a green building certification." This description fits the EPA Energy Star program, which focuses on reducing energy consumption rather than "greenness." Energy Star for commercial buildings has certified about 25,000 buildings, about the same number of buildings certified by LEED, according to Yudelsen. [3]

He further noted that green building claims for improved employee health and productivity are backed by weak empirical evidence. He acknowledges that there are significant commissioning and consulting costs and notes that for most owners and developers pursuing green building certification, unless mandated by policy or driven by government incentives, is something for which they have little interest.

Yudelsen then gives several recommendations including cutting costs of delivery, simplifying the criteria (LEED has become more complex over time) and focusing on fewer issues. In terms of fewer issues, he notes that 60 percent of the points in LEED and Green Globes deal with three issues: energy, water and waste and suggests a rating system that deals only with these key

performance indicators. He also suggests more automation to obtain critical information. He summarizes by saying that green building certification market share will grow only if it is understandable and cost-effective.

Review of Metrics

After reading these articles, I wondered about USGBC's recent success and reviewed their online annual reports for the years 2007-2014 (2015 data is not yet available). The summary of revenues and changes to net assets (the non-profit way of reporting what would be profits) is listed in Table 1. [4] The table shows a peak in revenues in 2009 of $108 million and a decline to $61 million in 2013 with a small resurgence to $65 million in 2014.

Year	Revenues ($1,000,000s)	Change to assets ($1,000,000s)
2007	46	11
2008	79	17
2009	108	15
2010	75	-8
2011	73	1
2012	76	4
2013	61	-6
2014	65	-7

Table 1 – LEED Revenues and Change to Assets 2007-2014

I also verified some of Yudelsen's numbers by checking the US Department of Energy 2011 Building Energy Data Book (the most recent version). [5] Table 3.2.1 of that report estimates there are about 5 million existing commercial buildings and about 80 billion square feet of existing commercial space. Architecture 2030 provides other information that could be relevant in verifying the data given, including an estimate of 275 billion square feet of existing space which undoubtedly includes existing housing. The Architecture 2030 website notes that during normal economic times, approximately 1.75 billion square feet of buildings are torn down each year, 5 billion square feet are renovated each year, and 5 billion square feet of new buildings are constructed each year. [6]

To complete the overall picture I reviewed the Energy Star rating systems for commercial buildings, which confirmed that 25,000 buildings had been rated by this system. [7] I also reviewed a document (February 23, 2015) by USGBC entitled Green Building Facts [8] that claimed more than 3.6 billion square feet of building space was LEED certified as of January 2015. This is about 4.2% of the 85 billion square feet of commercial building space, slightly higher than the 3% number given by Yudelsen. My hypothesis that green building has had a relatively small effect is verified, at least with commercial buildings.

As I noted earlier, Yudelsen said that green building activity has peaked in the U.S. at about 4,500-5,000 projects per year, as measured by LEED, Green Globes and Living Building Challenge projects. Figure 1 shows the distribution of the three rating systems. Clearly LEED dominates.

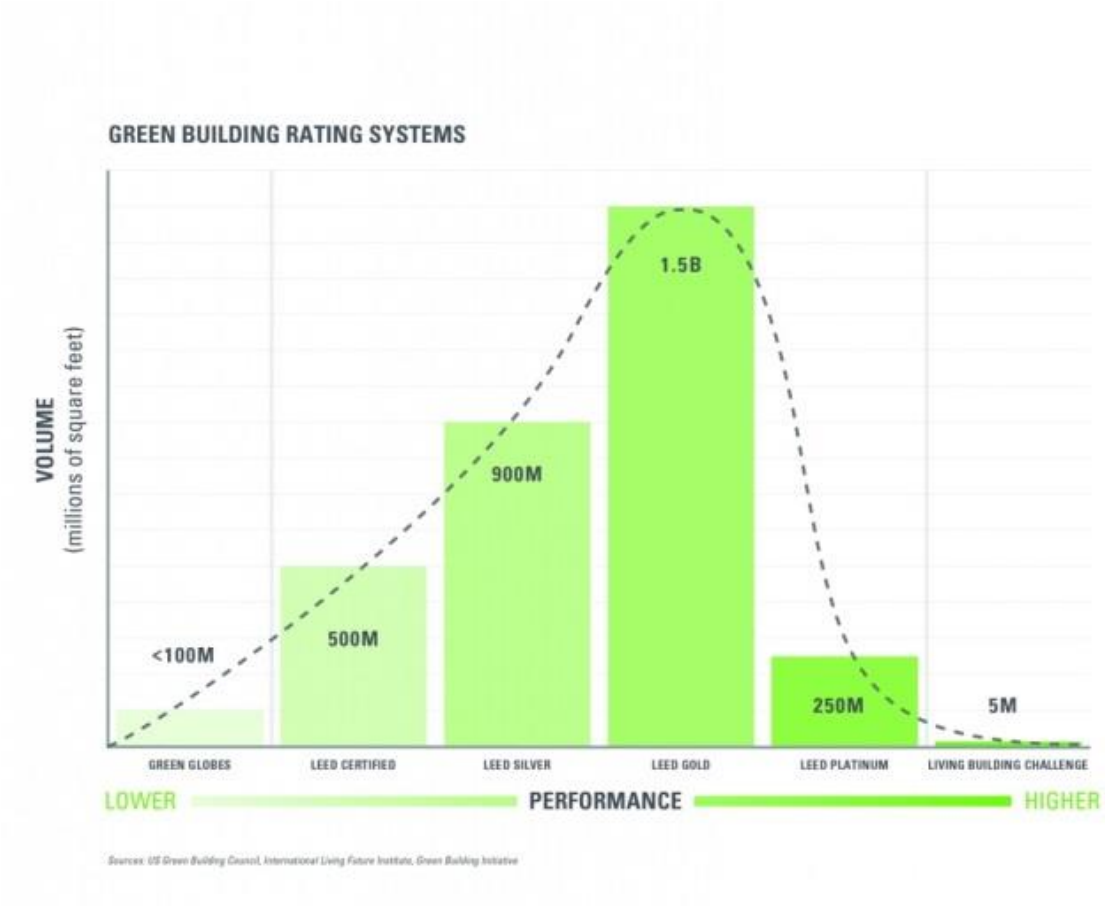

Figure 1: Distribution of Green Projects in Millions of Square Feet [9]

Builders have the option to build conventional buildings rather than green buildings and most of them do so. This does not mean a conventional building is energy inefficient because conventional buildings are subject to energy regulation by the national building codes. A building code is a set of rules that specify the minimum standards for construction, such as buildings, as well as non-building structures, such as roads. The main purpose of building codes is to protect public health, safety and general welfare as they relate to the construction and occupancy of buildings. The building code becomes the law of a particular local or regional jurisdiction when it is formally enacted by the appropriate governmental or private authority.

The International Building Code (IBC) is a model building code developed by the International Code Council (ICC). It has been adopted throughout most of the United States. Part of the code addresses energy and is called the International Energy Conservation Code (IECC). It sets the energy limitations. It is updated every three years. However, municipalities do not have to adopt the most recent version and most take years to do so.

The energy consumption requirements set by the building codes are described and measured in ways that are very different than for green buildings. It has been noted that green is a color and when used to describe buildings takes on an entirely different meaning. Trying to define a green building is difficult since it must incorporate a wide variety of views and definitions that are subjective and personal to the definer. Since it is impossible to define this specifically, the next step is to define green rating systems of which LEED is one and Green Globes is another.

Green building as LEED defines it consists of four different ratings, Certified, Silver, Gold and Platinum. Green Globes rating levels include four levels defined as 1, 2, 3 or 4 globes. For both organizations, the final ratings are set by the certifier, e.g. LEED or Green Globes. For energy codes, the metrics are much simpler since they involve physical reality, including metrics for thickness of insulation and a measure for maximum air loss. Such measurements are easily understood by engineers and builders,.

Green Building and Houses

The history of rating systems for homes is different than that of commercial buildings. The following table shows total housing units constructed from 2000 through 2014 with subdivisions for conventional buildings built to code, green buildings built to some rating system, and energy efficient buildings such as Energy Star. LEED for Homes was developed some years after the original LEED program for commercial buildings. My interest is more in home building than commercial buildings and LEED information from homes is easier to obtain and compare than data from LEED commercial buildings. Since commercial buildings vary so much in size, unit counts are less significant than total square footage. In terms of homes, a count of houses built is a sufficient indicator. Table 2 summarizes 16 years of housing units built.

Housing Units (in Thousands)																	
Year	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**Total**
US Total Housing Stock 2015																	118,000
Housing Units Completed	1,574	1,571	1,648	1,679	1,842	1,931	1,979	1,503	1,120	794	652	585	649	764	883	966	20,140
Conventional Category																	
Conventional Total	1,557	1,534	1,566	1,562	1,705	1,761	1,776	1,369	994	669	504	422	508	620	740	855	18,142
Green Category																	
Local/Regional Green (est)	7	7	7	7	7	7	7	7	8	9	9	8	7	7	7	6	117
LEED for Homes										2	3	7	15	17	18	16	78
NatlGrnBldStnd											1	4	8	14	15	15	57
Green Total	7	7	7	7	7	7	7	7	8	11	13	19	30	38	40	37	252
Energy Efficient Category																	
Energy Star	10	30	75	110	130	160	190	120	110	105	126	127	101	92	87	64	1,637
Building America						3	6	7	8	9	9	12	0	0	0	0	54
Builders Challenge												5	10	13	15	8	51
Zero Ready Energy														1	1	2	4
Energy Efficient Total	10	30	75	110	130	163	196	127	118	114	135	144	111	106	103	74	1,746
Green & Energy Efficient Total	17	37	82	117	137	170	203	134	126	125	148	163	141	144	143	111	1,998
% G and EE/All Housing Units	1%	2%	5%	7%	7%	9%	10%	9%	11%	16%	23%	28%	22%	19%	16%	11%	10%
% G/All Housing Units	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	2%	3%	5%	5%	5%	4%	1%
% EE/All Housing Units	1%	2%	5%	7%	7%	8%	10%	8%	11%	14%	21%	25%	17%	14%	12%	8%	9%
% Energy Star/All Housing Units	1%	2%	5%	7%	7%	8%	10%	8%	10%	13%	19%	22%	16%	12%	10%	7%	8%
% G & EE/All Hsng Units xcpt ES	0%	0%	0%	0%	0%	1%	1%	1%	1%	3%	3%	5%	5%	5%	5%	3%	1%
% ES	1%	2%	5%	7%	7%	8%	10%	8%	10%	13%	19%	22%	16%	12%	10%	7%	8%

Table 2 – New Housing Market from 2000-2015

The information in table 2 is divided into three categories – conventional, green, and energy efficient. Conventional homes are those that are not green or energy efficient and their energy limits are set by the IECC building energy code.

The Green category includes a sub category of Local/Regional Green, which includes several dozen local or regional green rating systems. These are in decline, being replaced by national green certification systems. LEED for Homes is the category that has more homes built to its

specifications than any other. Next is NGBS which stands for National Green Building Systems. LEED for Homes became available in 2009; NGBS became available in 2010. Note that LEED homes represent 0.05% of the total stock of 118 million homes and 1.4% of the homes built in the period from 2009-2014.

Local/Regional Green housing starts have declined over time as builders selected national standards. The estimates for starts of this category were derived from a myriad of sources as well as personal contacts. An article in Wikipedia [10] serves to verify my 111,000 estimate noting: "NAHB members have been building green homes for years – each one appropriate to the climate, geography and market preferences of the communities where they build. Additionally, these builders certified more than 115,000 homes in local HBA green building programs between 1995 and 2008."

The third category is Energy Efficient and its main divisions are Energy Star, Building America, Builder's Challenge and Zero Ready Energy Homes.

The first Energy Star home was built in 1996. From the period 1996-1999 only a small number were built and the table above begins its count of Energy Star homes in 2010. The objective of Energy Star homes was to reduce energy use by 15% compared to existing codes.

This was changed to 30% with the release in 2011 of Energy Star Version 3. The number of Energy Star units dropped significantly in 2012 and declined further in 2013, 2014 and 2015. This is partiality the result of increasing the performance requirements for Energy Star in 2012 which made it more difficult and expensive for builders to obtain certification.

Building America, Builders Challenge, and now Zero Ready Energy homes are versions of the same program that have evolved over time. Note that Building America homes stopped being produced after 2011. The designation for Building America's better performing homes was changed to Builders Challenge. Builders Challenge is now being replaced with a newer designation of Zero Ready Energy. The Building America program, part of the Department of Energy, is more focused on research than production. It was never intended to be a certification program. It set a higher energy standard than Energy Star. In recent years, the Building America program has become more focused on determining how to retrofit existing homes to reduce energy rather than developing high performance new homes.

The lower section of Table 2 summarizes different sub totals measured in percentages. In this section the letter "G" covers historical local green certifying systems as well as national green programs such as LEED and NGBS. The letters "EE" stand for energy efficient and cover mostly Energy Star as well as the different types of Building America homes.

Note that the "G" (green) units attained a 5% market share in 2012 and maintained that level in 2013 and 2014, dropping to 4% in 2015. "EE" (energy efficient) units reached a 25% market share in 2011 and declined to 8% in 2015, partly due to the more stringent requirements for Energy Star Version 3 certification. Combined, G and EE units reached 28% in 2011 and declined to 11% in 2015. This is somewhat surprising particularly as the news about the climate crisis worsens. Yudelsen earlier noted that "green is not taking off"; it may have reached some saturation point.

Green and Energy Efficient Analysis

There are several ways of looking at the concept of using the color green as a measure of energy efficiency or general environmental considerations. There are six aspects to this:

1. General Green Products
2. Energy Efficiency versus Green
3. Competition from more stringent Building Energy Codes
4. Shift from Energy Consumption to CO_2 Emissions
5. "Metaphoric" Measures
6. Energy Rating Systems

1. General green products – In an article entitled "Green Voted Most Despised Buzzward" [11] a poll of 125 people found green to be the top vote getter. See Figure 2. The plurality of respondents chose "green" as their least favorite word.

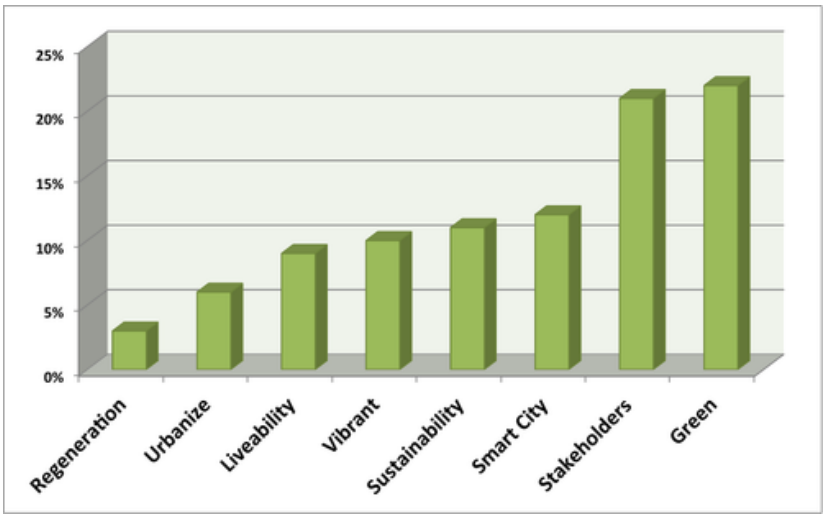

Figure 2: Short survey of Disliked Common Words

The author points out that "green" can be confused with "energy savings" and "energy efficiency," acknowledging that these terms are also not well defined. The article quotes well known Passive House architect Chris Benedict as saying "it's often the case that the term "green" applies to what happens during the modelling phase, not necessarily what comes out when the building is constructed." This comment points out that green often refers to the materials used in the building which make up the "embodied energy" in the structure. In terms of CO_2 emissions, the "operating energy" represented by the fossil fuels used to heat, cool, and light the building is more important.

The Federal Trade Commission (FTC) has responsibility for truth in advertising. The agency has long been concerned about so called "green" claims. A major effort was made to strengthen the labeling for green products. The agency has produced a document entitled "Green Guides" in an attempt to manage the sometimes outlandish green advertising. [12] Nonetheless, green is an overused concept that does not inspire confidence.

2. Energy efficient versus green – Currently, emphasis continues to shift toward energy efficient buildings, represented by the Energy Star programs. As noted above, the right most column of Table 2 shows that 9% of the total residences built from 2000 through 2014 were EE

(Energy Efficient) homes while 1% of the total market for the same period were G (Green) homes.

3. Competition from More Stringent Building Energy Codes – As building codes set higher performance standards for energy reduction, some builders construct to its parameters rather than LEED or Figure 3 illustrates the savings in energy consumption brought on by newer building codes.

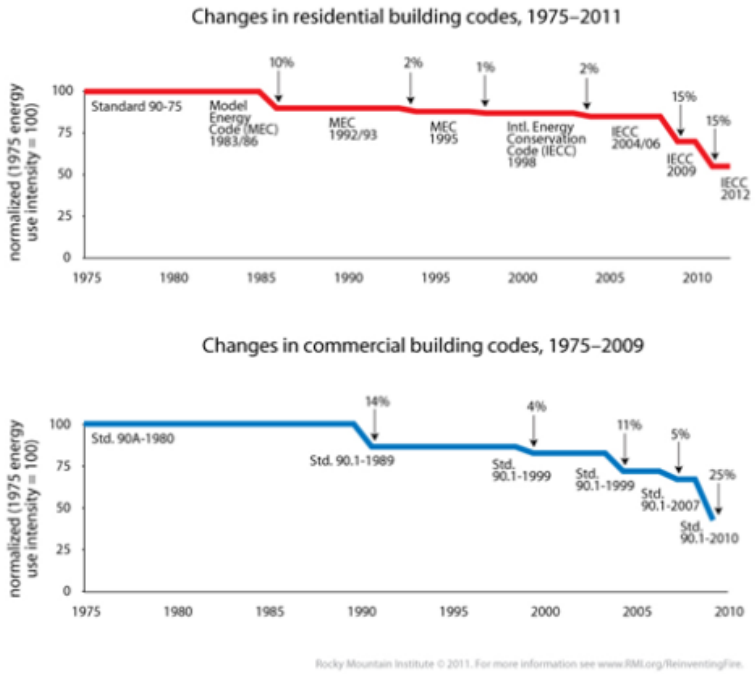

Figure 3: Energy Use Intensity Changes in New Building Codes [13]

The top half of Figure 3 (titled "Changes in residential building codes, 1975-2011) shows that there have been six reductions in allowed energy usage since 1975 for a total cut of 45%. However, this does not necessarily convert to less energy usage since house size has grown significantly in terms of average square footage since 1975. The typical house size in 1975 was 1500 square feet of conditioned space while the average square feet of size of a new home in 2014 was 2,657 square feet. [14] [15]

So the 45% reduction in energy use based on code efficiency is offset by a 60% increase in house size which means more energy consumption. This is analogous to better mileage for cars relative to engine efficiency offset by a move to bigger cars. This was discussed in a brief DOE report "Newer U.S. homes are 30% larger but consume about as much energy as older homes." [16] The report compared homes built before 2000 to homes built between 2000 and 2009. The exact relationship between code changes and building size has not been fully evaluated.

It is not commonly understood that energy efficiency often leads to more consumption. This is called the rebound effect or Jevons Paradox. The average home size was 983 square feet in 1950, 1,500 square feet in 1970, 2,080 square feet in 1990 and 2,392 square feet in 2010. At the same time the average family size has declined. The result is an increase in square feet per

person from 292 square feet in 1950 to 945 square feet in 2010 (Figure 4). The point is clear – house size increases mean more fossil fuel consumption, while at the same time efficiency increases mean less fossil fuel consumption. Size growth and energy efficiency cancel each other out to some extent.

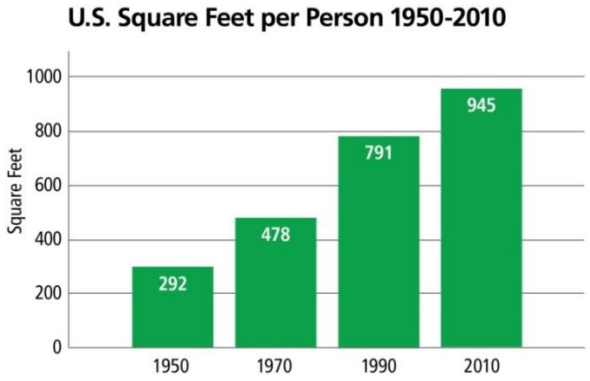

Figure 4 – Square feet per person in homes 1950-2010

Another important consideration relative to energy building codes is that they are not adopted universally with each upgrade. Each state and sometimes individual locales will adopt the codes at different times as shown in Figure 5. The chart in Figure 5 was prepared in March 2015; only two states had adopted the 2015 building code and only 11 had adopted the 2012 code. This shows that code adoption in different states and regions is a slow process. This could change with public pressure and new government policies.

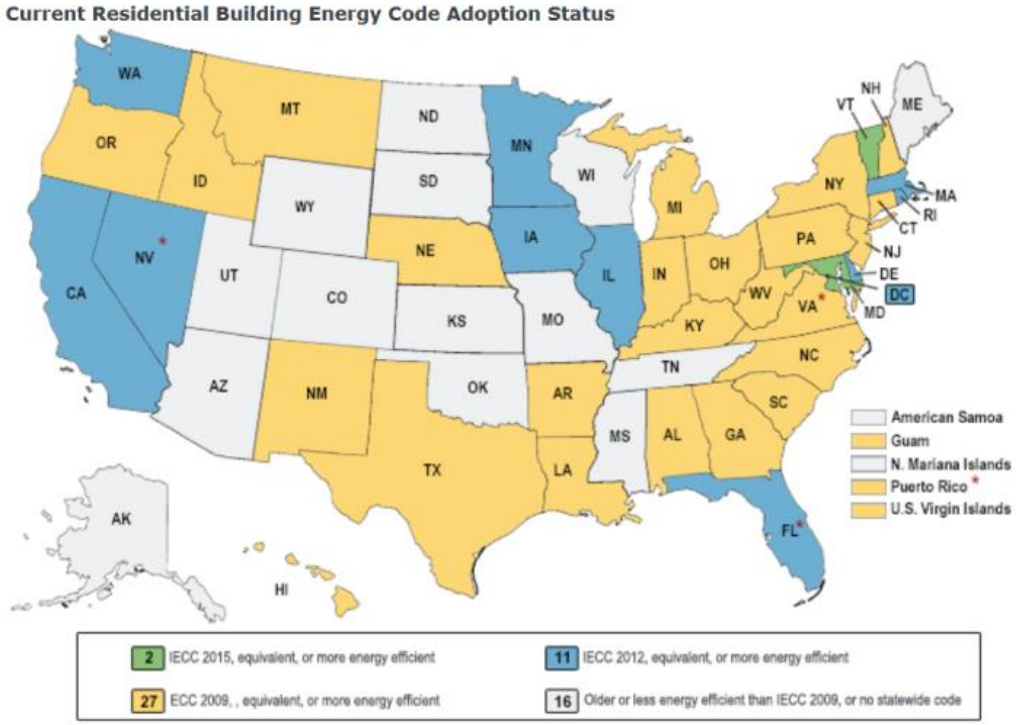

Figure 5 – Building Code Level by State as of March 2015

4. Shift from Energy Consumption to CO_2 Emissions There is a growing realization that the main environment problem facing humanity is climate change, which ties directly to CO_2 generated by fossil fuel consumption. The other items that green building purport to measure are becoming less and less meaningful. This includes categories such as transportation of building materials, water consumption, air purity, etc. Although important they fade into insignificance when considering the implication of climate change. And as more of these secondary categories are included in green rating systems, energy consumption and its associated CO_2 emissions become less significant.

5. "Metaphoric" Measures – There is a plethora of rating categories and rating systems. The non-energy secondary items merely confuse the situation by obscuring the actual fossil fuel use. For example, LEED and NGBS (combined 33,000 units out of 883,000 units in 2014 – about 4%) have gradations into the following six categories: certified, bronze, silver, gold, platinum, and emerald. The two organizations share the same names – silver and gold – for two of their categories but there is no relationship between rating levels with the same name from different organizations. There is simply no way to compare the different gradations. Use of these names is not trivial. What they communicate is some sense of value – the more expensive the metal the better the rating. But there are no scientific metrics of performance tied to the names and thus they are somewhat meaningless. These kinds of ratings obscure the number more and more people are seeking, that is, how much CO_2 is being generated from consuming energy. Since green cannot be measured but CO_2 emissions can, confusion reigns.

One response to this situation was a 2014 Final Rule from the Department of Energy that addressed this directly. A Final Rule is a process where government agencies can issue binding requirements once a process has been followed. [17] The rule issued was called "A Green Building Certification Rule to Support Increased Energy Measurement and Efficient Building Design". It was published on October 10, 2014. [18] Essentially it requires measuring and publishing energy use data for federal buildings. LEED does not require actual energy use data to be published. In fact, many owners of LEED certified buildings refuse to publish this data. LEED can collect the data but will not publish it without owner permission. The new DOE rule will make it mandatory to publish actual usage, which can then be compared with the computer modeling used by LEED to rate commercial buildings. Unfortunately the rule applies only to government buildings.

6. Energy Ratings Systems – The Home Energy Rating System (HERS), developed by the Residential Energy Services Network (RESNET), is another important energy use measure for homes. Certified RESNET HERS raters have rated over 1 million homes since 1995. [19] The RESNET HERS Index is the nationally recognized system for the inspection and calculation of a home's energy performance. It is a straightforward scale as shown in Figure 6.

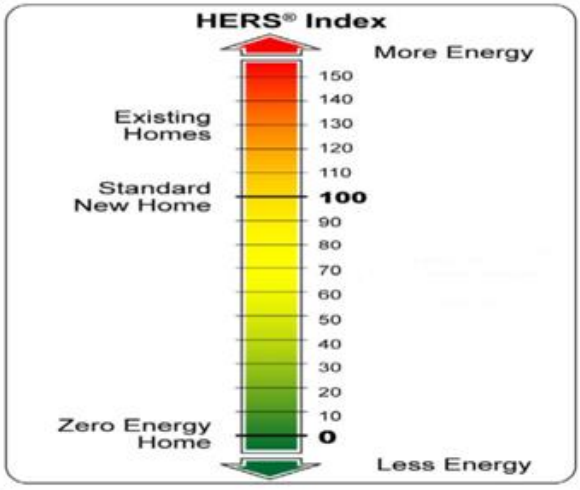

Figure 6 – HERS Rating Index [20]

The history of RESNET is an important one. [21] In 1981, a group of mortgage industry leaders set up the National Shelter Industry Energy Advisory Council to establish a way to measure the financial savings generated by energy efficient features in a home and also to credit that home's energy efficiency in the mortgage loan. This led to the formation of a national non-profit organization known as the Energy Rated Homes of America. In April 1995, representatives of the national mortgage industry, the National Association of State Energy Officials, and Energy Rated Homes of America founded the Residential Energy Services Network (RESNET). RESNET's task was to develop national standards for home energy ratings and to create a market for home energy rating systems and energy mortgages. RESNET's activities were initially guided by a mortgage industry steering committee, composed of the leading national mortgage executives. In 2002 RESNET became incorporated as a 501 (c) (3) non-profit organization and Energy Rated Homes of America was merged into the organization, with a Board of Directors governing RESNET.

The recently approved International Energy Consumption Code (IECC) for 2015 has included HERS as part of the requirement for buildings to meet a certain energy performance level. After more than a decade of development, an energy standard for homes linked to building codes is now in operation.

Green and Energy Efficient Effect – Measurements of Energy and CO_2 Savings

The limited number of houses and buildings certified by any rating system (green or energy efficient) is one aspect of high building CO_2 emissions in the US. But equally important is to measure the total emissions reductions for all homes. To do this "green" has to be changed into a percent savings with some goal in mind, in this case CO_2.

The major world goal of an 80% reduction in CO_2 by 2050 will be met partially by renewables, partially by energy efficient building envelopes, partially by new more efficient furnaces and appliances, and partially by deliberate efforts of individuals and households to use less energy and sacrifice some comfort and conveniences for lower CO_2 emissions. To do this, a clear understanding of the effectiveness of actions is needed and can only come if each action can map to some measure of CO_2 reduction.

The next two, Tables 3 and Table 4, illustrate how this can be done in the case of housing. Table 3 is a summary of Table 2 used as the basis for computation in Table 4.

Energy Savings - Housing Units (in Thousands)		
	2014	2000-2014
US Total Housing Stock	118,000	118,000
Housing Units Completed	883	19,174
Conventional Category		
Conventional Total	737	17,284
Green Category		
Local/Regional	7	111
LEED for Homes	18	62
NatlGrnBldStnd	15	42
Green Total	40	215
Energy Efficient Category		
Energy Star	87	1,573
Building America	0	54
Builders Challenge	15	43
Zero Ready Energy	4	5
Energy Efficient Total	106	1,675

Table 3 – Category Summations from Table 2

The first entries in Table 3 are summations of information in Table 2 which show the distribution of homes by the designations of green, energy efficient and conventional. (Conventional homes are the total units built minus the green and energy efficient ones.) Energy efficient homes are dominated by Energy Star which was originally designed to save 15% of the energy of homes built to whatever code was predominant at that time. Note from Figure 3 that there was little change in terms of the energy code until about 2008. Energy Star Version 3 was delivered in 2013 and the total Version 3 homes built are roughly the numbers in the 2013 and 2014 columns. The units built in these two years (157,000 units) are about 10% of the total Energy Star homes built through 2014 (about 1.5 million units). For purposes of this analysis the original 15% energy savings associated with the earlier versions of Energy Star is increased to 20%.

The energy savings associated with green homes is uncertain, particularly since there are so many different rating systems and so many different sub-categories within each rating system. Green energy savings are estimated to be 25% for the purpose of this analysis. The reader may make his or her own computations with different estimates of energy savings since the analysis is straightforward.

Energy Savings - % Reduction: 2014 and 2000-2014		
	2014	2000-2014
Market Share-Housing Units Completed		
Conventional Total %	83.5%	90.1%
Green Total %	4.5%	1.1%
Energy Efficient Total %	12.0%	8.7%
Green and Energy Efficient Total %	16.5%	9.9%
Energy Savings-Housing Units Completed		
Conventional Total (0.0% estimated savings)	0.0%	0.0%
Green Savings (25% estimated savings)	1.1%	0.3%
Energy Efficient Savings (20% estimated savings)	2.4%	1.7%
Green and Energy Efficient Energy Est. Savings Total %	3.5%	2.0%

Table 4 – Energy Savings Analysis 2000-2014

The number of green and energy efficient buildings combined (1,890,000) were 9.9% percent of total units built (19,174,000) in the period 2000-2014. The number of green buildings (215,000) was 1.1% of the total units built (19,174,000). The percent of energy savings for green buildings is the percent of green buildings (1.1%) multiplied by the percent of savings (25%) or 0.27%. The percent of energy savings for energy efficient buildings is the percent of energy efficient buildings (9%) multiplied by the percent of savings (20%) or 1.8%. The green and energy efficient savings combined is 2%, hardly significant when facing the need to cut CO_2 emissions by 80% in 35 years.

To complete this evaluation, a similar analysis must be applied to the total housing stock of 118 million residences. Homes last a long time (50-100 years) so older homes built before 2000 dominate energy consumption and CO_2 emissions. Table 5 shows the effect of green and energy efficient homes on the total housing stock. The energy savings is only a third of one percent.

Energy Savings-% Reduction: Total Housing Stock	
Market Share-Total Housing Stock	
Conventional Total - % of total housing stock	14.6%
Green Total - % of total housing stock	0.2%
Energy Efficient Total - % of total housing stock	1.4%
Green and Energy Efficient Total %of total housing stock	1.6%
Energy Savings (%) -Total Housing Stock	
Conventional Total (0% estimated savings)	0.0%
Green Total (25% estimated savings)	0.05%
Energy Efficient Total (20% estimate)	0.3%
Energy Savings Total %	0.33%

Table 5 – Emissions saving of total housing from Green/Energy Efficient Building

It is clear that green and energy efficient buildings have not made a dent in energy consumption. Some might argue that the existing stock has been improved over the decades; seven million weatherized homes under the WAP program attest to that as do about half a million Home Performance for Energy Star residences. Even more important in reducing CO_2 is the periodic upgrading of furnaces and appliances in the vast majority of the 118 million homes in question with more efficient units. This analysis does not include the effects of such upgrades.

Conclusions

Green Building began more than two decades ago, a possible seminal starting event being President Clinton's announcement of the *Greening of the White House Initiative* on Earth Day 1993. This is the same year that Rick Fedrizzi, David Gottfried and Mike Italiano established the U.S. Green Building Council (USGBC). [22] USGBC launched LEED version 1.0 in August, 1998.

The first Energy Star home was built in 1996. [23] It has been about 20 years since these initial efforts began. There have been a large number of homes and buildings constructed under the title of green building and of energy efficiency; however, in terms of the total climate effect it has been marginal, less than a single percent difference.

Many voluntary programs have risen and faded and even the leading national programs such as LEED and Energy Star for Homes seem to be flattening out in terms of market share. However, this has to be considered within the context of increasing energy performance requirements with updates of programs and new versions of computer software. It is to be expected that higher performance requirements mean greater cost and complexity. There may be marginal interest until the industry gets some solid experience. Most of these efforts are being done on a voluntary basis so progress is slow.

The situation is summarized in the annual report of "U.S. Greenhouse Gas Emissions and Sinks: 1990-2013" released in February 2015. Table 6 shows the trends since 1990. Note that residential emissions are not declining rapidly, only about 3% less in 2013 (329.9 $MMTCO_2$) as compared to 2009 (336.7 $MMTCO_2$), which varied little from the emissions in 1990 (338.3 $MMTCO_2$).

Gas/Source	1990	2005	2009	2010	2011	2012	2013
CO_2	**5,126.8**	**6,156.4**	**5,553.0**	**5,754.2**	**5,618.7**	**5,418.7**	**5,556.0**
Fossil Fuel Combustion	4,740.7	5,753.5	5,226.1	5,401.2	5,266.6	5,062.3	5,195.5
Electricity Generation	1,820.8	2,402.1	2,146.4	2,259.2	2,158.5	2,022.7	2,040.5
Transportation	1,493.8	1,891.0	1,747.0	1,764.1	1,745.4	1,735.9	1,754.0
Industrial	842.5	828.8	728.3	775.6	773.7	783.9	817.3
Residential	338.3	357.9	336.7	335.1	327.5	283.4	329.9
Commercial	217.4	223.7	223.8	220.5	221.3	197.5	221.5

Table 6 – CO_2 Emissions $MMTCO_2$ Eqv. [24]

In spite of the good work in the last decade, the climate situation is changing so fast that the current approach may no longer be sufficient. Foremost is the fact that the buildings constructed under "green building" and Energy Star programs will not meet the goals of a 80% reduction by 2050, unless such homes are retrofitted at some point in the future.

The German Passive House has proved the concept that buildings can be constructed that use 80% less energy for heating and cooling. They provide one measure of performance but with only 30,000 – 60,000 worldwide and with only a few hundred in the US, the program cannot claim to have made deep market penetration. It does prove feasibility and many new products have been developed to meet that standard, including highly efficient triple pane windows, heat and energy exchangers, ductless mini-splits and much better materials for insulation and air sealing. For the first time builder, such standards are not easy to achieve and costs are significantly higher, probably at least 10% for the first few models built. With experience the difference should be less than 5%. However, this will eventually be recovered with lower heating and cooling bills.

The additional building cost difference has been a barrier. Yet when Life Cycle Assessments are applied, which consider CO_2 savings over the life time of the building, not only is energy saved but also money. This is countered by an as yet unresolved concern that the benefits may not accrue to the owner of the home unless he or she lives there a long time. With the typical person moving every seven years it is doubtful if that is a sufficient payback period to make up for the incremental additional costs. But it is still unknown if the resale value of a much better performing home will offset the original cost. One small study suggests that the premium for an Energy Star home is not recovered when the home is sold.[25] A California study shows mixed results and includes Energy Star homes as well as green homes. [26] This is a major barrier that has been under discussion for decades with no clear resolution.

Existing homes certainly benefit from new technologies and practices that are developed when building high performance homes. One impressive program is Home Performance with Energy Star (HPwES) that addresses energy reductions in existing residential buildings. The first HPwES retrofitted homes were completed in 2002.[27] [28] Cumulative HPwES homes through 2014 number about 428,000 units. [29] Note there are about 118 million residences in the US. HPwES homes claim a reduction in energy consumption of about 20%.

HPwES is a "market rate" program meaning the home owner must bear most of the costs. Another important program that has benefited from the years of work on energy efficiency is the Weatherization Assistance Program (WAP). This program began in 1976 and to date has energy retrofitted about seven million homes. Of great importance is the last million or so homes retrofitted, which were done under the Obama Recovery Act that provided $5 billion for this work between 2009 and 2012. Improvements for more recent homes are more extensive than in the early years of the WAP program. These more recent homes have efficiency improvements in the 10-20% range at a cost per home in the $7,000 – $8,000 range.

The energy improvements available that came from a combination of Energy Star, Building America, WAP, HPwES and numerous state and local green building programs have been a very positive step in the nation's energy history. Without the information obtained by these initiatives responding to the climate crisis would be even more difficult.

Predictions and Recommendations

When history is written the concept of Green Building may be viewed as a smokescreen covering up the poor energy efficiency of U.S. commercial and residential buildings. By using Olympic metals as a measure of building improvements as a whole without recourse to physics, the industry has been able to pay lip service to better buildings suggesting "it doesn't have to cost more to be green"! This has led to a lack of understanding of basic thermodynamics in the population at large and kept people complacent. The key metric of CO_2 emissions must be separated from the wider class of improvements since it is CO_2 that threatens life on the planet and it cannot be obscured by unrelated general improvements to buildings.

The nation and the world have long had building codes which have been applied to building safety and durability. These must be extended into energy and greenhouse gas emissions. The failure to adopt the more restrictive codes in a timely manner is irresponsible. Changes to energy codes to meet the 80% emissions reduction goal by 2050 should be done immediately. And the more stringent codes must be applied to all new building as quickly as possible.

Because annual new home starts are small (1/2 to 1 million) the building industry must shift more to home performance improvements to existing homes to make a real dent in CO_2 emissions. Experience with new homes in terms will help feed knowledge and technology into the retrofitting industry. However, there can be no delay in waiting for new codes.

Home owners must become personally involved in energy reduction efforts on their own homes. Government has been too slow to date. There is a long standing trend in home owner maintenance and home improvements. The will and even some of the skills are already present in parts of the population. Suppliers such as Lowes and Home Depot provide classes and the Internet contains a massive amount of information for this kind of activity. As people become

more and more concerned about climate change they will begin to see that the proper selection of a car and a continuous effort to reduce home energy use will be their greatest contribution.

Laws should be passed that require energy retrofits at the time of home transfer with a home is sold. This has been done in cases of safety issues for buildings. It is at that time that a significant amount of capital is being provided and some of it should be allocated to upgrades.

Schools should resurrect the shop programs of old to teach teenagers about the world they are living in and how their family life style threatens their personal future. Much of the effort to master and use computers should be redirected to real life skills that do not yet exist in the population but which will be required to mitigate climate change.

As time goes by and the climate crisis deepens, a home energy improvement movement analogous to the Victory Gardens of World War II should be implemented. Millions of people should be involved. Climate change can be considered as a crisis much more significant than the second world war and an appropriate mobilization will be necessary.

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