The Triple (Green) Bottom Line: Integrating the Environmental, Economic and Social Factors of Green Construction and Wood Waste

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About the Title: The basic concept of the triple bottom line equalizes people, planet and profit. More often than not, businesses are concerned with profit over people and planet. There are few issues that touch the three pillars of sustainability in greater severity than that of the housing industry. As the human population increases and resources become strained due to overexploitation and climate change, social justice issues like housing affordability and climate justice will become inextricably linked. By 2050 well over 60 percent of the world's population will live in cities. Personally, I would not be so passionate about natural resource science and climate change if I did not enjoy helping people.

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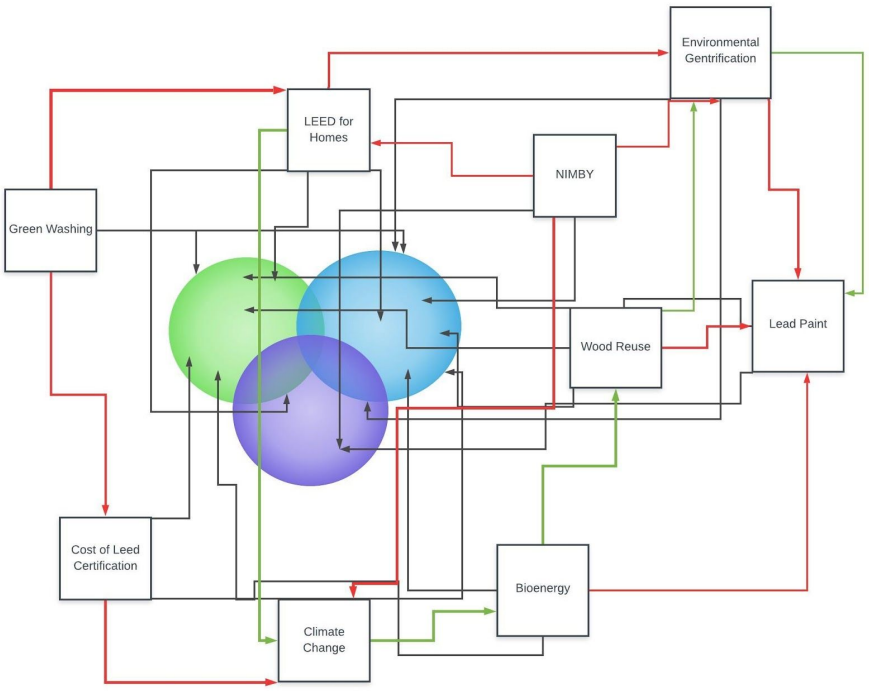
Abstract

The United States is at a crossroads when it comes to environmentally sound design. Social and consumer demands are shifting towards more environmentally conscious design and builders are noticing. However, green construction methods can often carry significant opportunity costs. This can lead to a level of "greenwashing" that not only diminishes the trust of the consumer but also slows the progress needed to solve social problems related to the housing crisis and climate change. However, there is hope in small builders who are following the practices and beginning conversations regarding green building. The following literature review describes the current state of green building, wood waste and environmental justice issues in the United States.

Visual Abstract/ Concept Map



Introduction:The Relationship Between Green Building Design, Urban Wood Waste and Bioenergy

While these three topics seem to not be related to each other in the slightest, they are all potential solutions of how to account for housing and construction waste, a form of urban wood waste. When a wood frame house is decommissioned, what happens to the wood? The wood enters the urban wood waste stream. In an ideal situation, wood that is in reusable pieces is utilized in construction again. This wood reuse is one of the ways a building can earn credits for a LEED (Leadership in Energy and Environmental Design) certification. But, what happens to wood that is not useful for reuse. Currently, the best solution is to turn this unusable wood into clean burning bioenergy or biofuel. What follows is a review of the literature surrounding these topics along with recommendations and suggestions for further research and development.

Definitions

Urban Wood Waste: Urban wood waste has a very complex definition. It is comprised of many different materials gathered from many different sources and in many different conditions. However, if outputs are supposed to serve as inputs for future industry, defining the types of urban wood waste is imperative. Within municipal solid waste, the EPA separates wood waste into two categories, wood and yard trimmings (Lyon and Bond 2014). The wood components include C&D waste, wood containers and pallets, and furniture and cabinetry. Yard trimmings includes cleared brush and trees that have been removed, mostly from landscaping operations.

The challenge with the phrase “wood waste” is that these two very different types of waste are often lumped together in some municipalities via single stream processing, making salvage very difficult (Lyon and Bond 2014). Any lumber, construction grade or felled trees that enter the waste stream could be processed to create such materials and are often buried under material that is more useful for compost or bioenergy production. An explanation of bioenergy production using salvaged wood waste is provided in subsequent sections. To ensure that all forms of urban wood waste are used in a way that minimizes impact to new resources and energy usage, better separations and definitions will be required.

LEED Building Design: Leadership in Energy and Environmental Design or LEED building design is a product of the United States Green Building Council. The United States Green Building Council was created in 1993, with the LEED rating system unveiling in 2000. LEED stands for Leadership in Energy and Environmental Design and applies to the materials and operations of the building. Points are awarded for sustainable material use, water efficiency, energy efficiency, design innovation, indoor environmental quality and overall sustainability. Less than 25% of buildings constructed in a given year can qualify for LEED status (USGBC 2017). Status is earned by achieving a certain number of points based on sustainable features. There are different standards based on building type. The points system is explained in **Table 1** LEED standards were updated in 2009 and 2014 to be more flexible and accurate in respect to energy efficiency. A new version of LEED standards was unveiled in 2018 (USGBC 2017; Miller et al 2008).

TABLE 1 Summary of LEED Standards

Certified	40-49 points
Silver	50-59 points
Gold	60-79 points
Platinum	80 points and above

Green Washing: Greenwashing is the deliberate misrepresentation of the environmental impacts in products with the goal of influencing consumers to purchase goods based on lessening environmental harm. Greenwashing relies heavily on imagery, colors, incomplete information or false claims and oftens appeals to implicit bias.

N.I.M.B.Y: NIMBY stands for "Not In My Backyard". It refers to a class of person who protests things or developments that could be potentially dangerous or unsightly in area where they interact but has no issues with such developments elsewhere. While this term can be usually used for things like power plants, landfills or even wind turbines it is often applied to low income housing developments or multi unit housing developments placed in higher income neighborhoods.

Gentrification: The process of transforming an area to conform to the tastes a class higher than the average current inhabitant. Zoning laws that allow for only certain designs in new construction for example can raise rents, pricing out long time residents of certain areas. While this creates economic gain in the short term, it also creates huge society inequity issues. This is also a cause for concern among certain green building techniques due to their price.

Assumptions and Methods

Assumptions

1. All people are behaving in their own self interests.
2. The primary concern of businesses is to increase their profits.
3. Implicit bias along racial, cultural and economic lines exists. It is difficult to document and prove but plays a role in decision making. Its common.
4. Governments, businesses and consumers are not always mutually exclusive groups.

Purpose

The purpose of this literature review is to describe the issues surrounding green building in the United States with the goal of inspiring potential solutions.

Methods

The following analysis consists of a thematically organized literature review incorporating a variety of both peer reviewed and non-peer reviewed sources. Non-peer reviewed sources were instrumental in the creation of the recommendations section at the end of the literature review. While the peer reviewed literature I examined was incredibly informative, it lacked the much-needed perspective of individuals who interact with the systems on a daily basis and whose livelihoods depend on this industry. Considering one of the central motifs of my analysis is the idea of finding holistic solutions based on compromise and integration of the best interests

of the environment, society and the economy it was essential that sources were examined from all parties involved.

Hypothesis

While green building is rapidly expanding in the United States out of necessity and profitability, challenges revolving around social justice issues and corporate pressures diminish the potential benefits of green building. Without addressing these issues, the true environmental impact of building will never be mitigated.

Review of Literature

Ecology of LEED Buildings and Urban Wood Waste: Smart Resource Use

LEED Buildings versus Traditional Buildings- Energy Efficiency

In countries with growing economies, energy use increases at 3.2% per year whereas in developed nations, energy use is growing at a rate of 1.1% per year (Newsham et al 2009). It would seem appropriate for developed nations like the United States to control energy usage as much as possible and one of the methods of doing so is to reduce building energy usage. LEED certified buildings are associated with energy savings. However, this is not always guaranteed. A study conducted by Newsham et al indicated that on average LEED buildings used 18-39% less energy per floor area than their conventional counterparts (Newsham et al 2009). This seems

obvious. Generally speaking, it was also determined that 28-35% of LEED buildings actually used more energy than their conventional counterparts (Newsham et al 2009). Many are taken aback by these results, especially when it was discovered during the analysis that additional stringency in certification level did not translate to greater savings in energy.

Even when LEED certified buildings are statistically more energy efficient, this is not always the case. Newsham et al also acknowledged that there were some considerations as to how their data was gathered and the timing of its gathering. The first is that many of the buildings that were analyzed were built in the first years of LEED certification but were studied after the technology had advanced considerably. Designs of the building could have also been altered over the years, leading to changes in energy efficiency that were not accounted for. Occupancy hours and hours of peak energy usage differ from building to building as well. Plug loads (the number of outlets for small electronics) are also greatly underestimated. There is also the last reason that the building might not have been commissioned properly (Newsham et al 2009). In response to this study, others examined LEED buildings to see if they gathered the same results.

A response to the Newsham et al study implied that energy discrepancies do exist and can be altered to give a more realistic view of energy savings. Scofield assumes that the majority of LEED certified offices are using less energy than comparable non-LEED offices and that much of the discrepancies come from skewed sizing data (Scofield 2009). Large buildings dominate the energy consumption of a set of buildings. While many think that this is an unfair method of calculating energy efficiency of a suite of buildings, this is based on simple physics. So while LEED buildings when examined individually use less energy than their same sized counterparts, on a whole, the energy savings are not statistically apparent. In order to solve the housing and

energy crisis that will occur in the United States, especially California in the coming years, these problems must be addressed.

Greenhouse Gas Emissions Savings from Wood Salvaging

It comes as no surprise that salvaging materials can produce fewer carbon dioxide emissions than acquiring new materials. Diyamandoglu and Fortuna found that under maximum salvage conditions, dimensional lumber had the highest rate of reduction in carbon dioxide emissions, greenhouse gas emissions and energy usage per ton when salvaged (Diyamandoglu and Fortuna 2015). Other studies are quick to extol the benefits of greenhouse gas reduction in wood products both new and salvaged. Ritter et al mention that fossil fuel consumption and by default greenhouse gas emissions are greatly reduced in the manufacture and use of wood products than they are in other types of construction materials (Ritter et al 2011).

It is apparent that compared to using alternatives that wood has the greatest greenhouse gas savings as a construction material, new or salvaged. Houses with wood based construction also required 15 percent less energy than thermally compatible houses made of other materials to manufacture. Over a 100 year lifespan, wooden houses have a reduction between 20 to 50 percent in emissions than homes constructed of other materials (Ritter et al 2011). It is also described that for each ton of carbon in wood products used displaces 2.1 tons of carbon in non wood products.

Most codes that describe green building do not require any level of life cycle analysis. Comparing any environmental benefits and risks without life cycle analysis is impossible. Current research in lifecycle analyses of buildings is underway.

Using Urban Wood Waste for Bioenergy

Using urban wood waste to generate bio energy is a viable "end use" option for wood that cannot be used in any other way due to consistency issues. Especially in areas like Mississippi, urban wood waste is inexpensive, widely available and with proper planning cheaper to acquire than dispose of. The study conducted by Joshi et al, is also a good example of using participant research to describe a waste management problem (Joshi et al 2015). Data was primarily collected through the use of a mail survey. This is beneficial because it allows participants to respond to questions at their own leisure and can lead to more thoughtful and honest answers. The total number of waste processing facilities surveyed in this analysis was 208 spread through Mississippi and other southern states. In the first section of the survey, participants were asked to describe the amount of wood waste their facility processed and estimate the recovered volume. The second section identified types of wood waste. The third section contained demographic information about the facility (Joshi et al 2015).

Obtaining demographic information on waste processing facilities is valuable information as it can describe a correlation between the availability of labor and amount of recycling or processing that can take place. This can be important information for identifying strategies and developing concepts for other states who want to adopt similar practices. Marketing information, including participants' perceptions on markets and ability to sell their product was also gathered (Joshi et al 2015). This can also serve as a rough indication of the willingness to

adopt sustainable technology and improvements in acceptability can be gauged with this data. Of the 208 surveys that were able to be delivered by mail, 64 of the surveys were returned leading to a response rate of 30.77% (Joshi et al 2015). It was determined that the overall amount of urban wood waste feedstock was not sufficient for running a large scale bioenergy operation in the state of Mississippi. Joshi et al state that with proper infrastructure changes that some bioenergy operations are still possible. The results of the survey indicate that the vast majority of the wood waste can be collected from disposal sites. Rubbish sites were also considered the better option for obtaining wood waste because it was relatively cleaner and in better condition. Combining this waste from logging industry residues could provide enough feedstock for significant bioenergy operation in Mississippi (Joshi et al 2015). Another factor that influences the recovery of materials for bioenergy is the availability of labor and technology for salvaging. Providing economic and policy incentives to encourage the growth of this industry would have the positive social benefit of employment opportunities and the socio-environmental benefits of clean energy (Joshi et al 2015).

The development of a wood based bioenergy infrastructure has implications for structure salvaging which in turn has implications for green building. In any wooden structure, there are sections than cannot be reused due to type,decay or a variety of other factors. Using these pieces of wood as feedstock for bioenergy would lead to a greater rate of reclamation of building materials and also provide a source of clean energy. There might be evidence to redesign buildings for potential reuse in bioenergy or at least adapt a cradle to cradle design strategy. Potential health implications of this process will be discussed in subsequent sections.

Economic Issues Related to Green Building Design

The Cost of Obtaining a LEED Certification

The cost of obtaining a LEED certification varies by building and status. It costs less money to recertify a building than it does to pursue a new certification. The flat fee for certifying a building regardless of level for the first time is $6500. The fee for buildings that have already reached silver, gold or platinum is $5200 (USGBC 2017). It is apparent that there is an incentive to achieve a higher status initially, as there is a cost savings on future recertifications. Additional fees must be paid for each level of certification and such fees are calculated by building type and square footage (USGBC 2017). Expedited review of plans, regardless of status costs $5000. Reviewing design and construction incurs another set of fees calculated by member status and gross floor area. Expedited review of design and construction plans and processes costs $10,000 (USGBC 2017). As an example, the minimum cost for a 50,000 sf building to obtain LEED Gold status would be $9,920 for the first time and $8,050 to recertify. Soft costs and other fees vary by area.

The Financial Incentives and Consumer Reactions to Green Building

One of the most important things to remember is that consumers now are starting to integrate environmental effects into their decision making when they purchase. There is also an ongoing debate of the placebo effect in green building and that builders might be spending money that

consumers will reimburse for effects that really do not exist (Miller et al 2008). The question that remains is if there really is a financial benefit to green building. On average, LEED certified buildings sold for a higher price per square foot than non LEED certified buildings in the years 2006 and 2008. The selling price for LEED buildings even increased during this time (Miller et al 2008). Given the construction market at this time, this factor provides some evidence that consumers value the label environmentally friendly.

Another factor influencing the costs and incentives for green building are another class of consumers, governments and nonprofits. These organizations oftentimes have the political clout to incentivise such choices. For example, if the city of San Francisco requires gold certification as of 2012 from projects larger than 50,000 square feet, the marginal cost of acquiring the gold standard would go down in the area (Miller et al 2008). The city of Portland has also undertaken green building measures to reduce infrastructure and energy costs in government buildings and large public structures (City of Portland 2002). While the initial cost of obtaining a LEED certification and subsequent maintenance fees are substantial, government incentives can make it affordable. The overall cost savings however, require further research.

Market Incentives for Green Building

One of the largest barriers to green building is the costs incurred by poor planning and execution. Market incentives that involve reductions in time, permitting fees and other costs are generally the most effective. Direct monetary payments from a city or county were stated to be a strong incentive by over 50 percent of developers. Depending on where the construction is taking place, reductions in the time required to obtain permits also provide significant cost savings. In San Diego, builders can get expedited plan checks for certain green building standards. This process saves seven to ten days which can provide significant cost reduction (NAIOP 2007). Generally, the plan check process can take up to two months. Density bonuses or financial incentives for building in a manner that maximizes the number of inhabitants while minimizing footprint were stated at the most significant incentive to green building.

One common statement among architects, developers and government officials was that cost is the greatest barrier to green building. Among these three groups, there were discrepancies among the effects of marketing and public opinion. While government officials state that public opinion and internal philosophy are significant incentives for green building, architects and developers are much more concerned with the bottom line. This can actually provide an incentive for less than ethical practices such as greenwashing or over exaggerated marketing on green building techniques with the purpose of lining investors pockets and not furthuring green building practices.

LEED for Homes

There are currently over 12,000 LEED certified housing developments in the United States. The first, based on the analysis provided by the database, was a single-family home in Oakland California in 2008 (LEED for Homes 2014). Texas and California, respectively, have the most LEED certified housing projects.

In other sections of this report, it has been mentioned that offering high density, multifamily housing close to employment opportunities in not only better for the environment but instrumental in solving housing issues and creating economic growth. Surprisingly, nearly 87% of the LEED certified projects in the United States are single family homes (LEED for Homes 2014). A graphical representation of these findings is provided in **Figure 2**,**3** and **4**.

Figure 2 Analytics of LEED Housing Projects 2014

California is located between BC and CO on the graph and has 1149 LEED Home Projects.

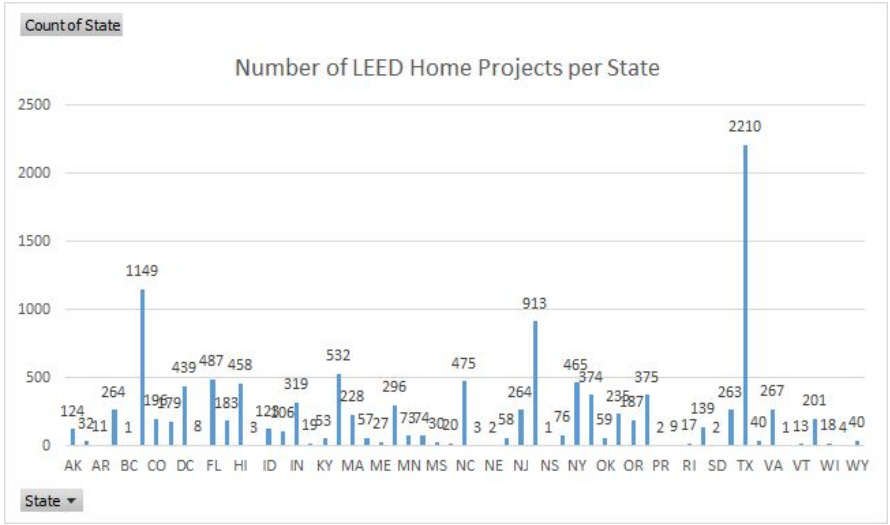


Figure 3 LEED certifications by building type 2014

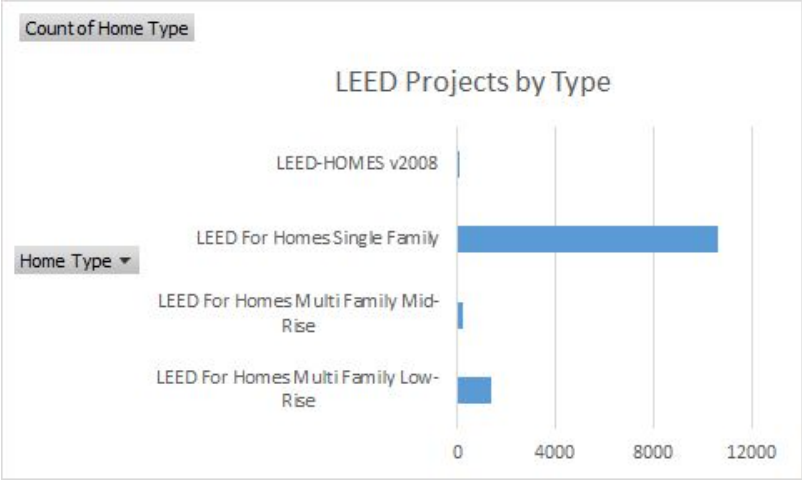


Figure 4 Number of LEED Certifications by Type 2014

This provides evidence to the notion that LEED certification is reserved for those who can afford it, which is counterintuitive to the idea that green building is a desperately needed action.

It is also plausible that this due to the fact that most building permits are issued for single family homes, rather than multifamily units. This can be for a variety of factors and even though many are in favor of affordable housing (especially in California), many do not want high density affordable housing units in areas with high property values for fear it could decrease them. A further discussion of zoning laws will occur in subsequent sections.

Incentives for Green- The Seven Sins of Greenwashing and Market Incentives for Dishonesty

It cannot be argued that the environment is now influencing the purchase of certain goods and marketing professionals are noticing. This can be extremely apparent in the housing market, where rosy images of energy savings, non toxic paint and water saving features are cleverly designed ploys to influence consumers. It is not to say that the above features are bad for the environment. They are in fact features that should be on every new building. However, over emphasizing their benefits coupled with using them to hide other unsavory aspects of construction is a classic example of greenwashing. As referenced in Dahl 2010, what follows has been named the "Sevin Sins of Greenwashing".

What are the Seven Sins of Greenwashing?

- **Sin of the Hidden Trade-off**
- **Sin of No Proof**
- **Sin of Vagueness**
- **Sin of Worshiping False Labels**

- **Sin of Irrelevance**
- **Sin of Lesser of Two Evils**
- **Sin of Fibbing**

While some of these do not apply directly to the housing industry, they all apply to green marketing, so their concepts can be illustrated. The most common is the sin of the hidden trade off. One can look at the features list for a new housing community and see a variety of water and energy saving devices which creates the illusion of negating any environmental harm. However, such developers do not always mitigate the damage they cause during construction and occasionally try to disguise it. In 2002, A.D Seeno Construction company knowingly destroyed a California Red Legged Frog habitat near Mt. Diablo in California for the purpose of building $500,000 homes. Seeno had originally paid a biologist to falsify reports that frogs were present when several breeding ponds, complete with frogs were discovered. Dead frogs were later discovered. In addition to well over $1,000,000 in fines, the biologist faced jail time and land from the Seeno family was seized to create a federal game preserve (May 2002). This hardly seems like behavior from a builder who openly claims how environmentally friendly their homes are.

In addition to damaging the environment, such actions diminish the trust of the green technology movement as a whole by employing one of the other deadly sins of greenwashing, the sin of the hidden trade off. When examining the features list indicated in **Figure 5**, one of the other notable sins of greenwashing is the sin of no proof. One of the clear indications of the sin of no proof is a catch all term energy conscious features. This term and related topics also encompass other sins of greenwashing. The strongest connection is between the sin of no proof and the sin of

irrelevance. Under the list of energy conscious features, they list items such as a whole house fan which on its own does not save electricity, especially as the model installed must activate the air conditioning unit in order to be used. In reality, this does not save electricity, especially as the average house model used in this analysis is over 2000 square feet. While the argument can be made that energy conscious labeling can be used of the next topics, the term non toxic will be used for the next two sins of greenwashing, the sin of vagueness and the sin of worshipping false labels. There is no true legal definition of the term non toxic, so labeling something like paint non toxic does not give a clear indication of its safety. Also, because there is no legally defined term of non toxic, it can be added to anything with little to no legal recourse if it is proven to be false. Above all, one of the greatest greenwashing sins in the housing market is the sin of the lesser of two evils. People are now making decisions based on environmental impact and marketing professionals know this. By simply advertising supposedly environmentally conscious features and implying that competitors might not do the same, less than forthcoming developers try to sway consumers to purchase their product by implying that it is less environmentally damaging when there really is little evidence proving that to be true. The greenwashing sin of fibbing, or flat out lying, is the least common but the most damaging. It is related to the lesser of two evils sin and in reality all other methods of greenwashing because dishonesty is a facet in all. It is the least common because in reality, it can be discovered and legal consequences do often occur.

The Social Issues of Green Building

Human Health and Well Being

There is much debate on whether or not green buildings have health benefits for their occupants. In a survey conducted by the USGBC, only 11% of respondents associated green building with well being. While numerous studies have determined that poor ventilation is a contributing factor to increased rates of respiratory illness, no effective rate of ventilation was found. Lower ventilation was also associated with increased poor perception of overall air quality (Wargo 2010). Where these statements become problematic is because a significant portion of this information was obtained via anecdotal evidence. It is not impossible to rule out that green building might have a placebo effect in certain respects, especially when in this study the optimum air filtration rate was not determined. There is also an argument that green building and LEED certifications ignore large portions of human health needs for the sake of environmental certification. According to an article by John Wargo of Yale University, LEED places relatively little emphasis on indoor air quality. Wargo argues that a building can be awarded the highest level of LEED certification , Platinum, without completing any credits for indoor air quality and that this ability can have impacts on health. He also mentions that there have been LEED approved materials that contain higher levels of toxic materials than one would think appropriate for an environmentally friendly building (Wargo 2010). What Wargo exposes is actually a common critique of most evaluative criteria which is the body that designed and examines the criteria might be biased to certain things, knowingly or unknowingly.

Because the LEED conservation model is performance based, energy conservation measures might overrule other equally important factors in overall sustainability. And because obtaining a higher level of LEED certification can make a developer eligible for certain benefits such as reduced interest rates, LEED is in effect subsidizing energy efficient, yet sick buildings (Wargo 2010). The way to remedy this situation is to encourage a balance within the LEED system. More research is needed to determine the primary methods of obtaining fairness in ratings.

Lead Paint and Salvaged Wood

An often overlooked issue with wood salvaging is the treatments used on the wood containing hazardous materials like lead. Because many buildings are decommissioned after nearly a lifetime of use, a building that is salvaged in 2017 could be full of leaded paint. Lead based paint can not only affect the salvageability and saleability of wood but can also have health effects, particularly in children. Because of the association many consumers have with green building, recycling and health it seems ironic that some types of green building could put the health of sensitive groups at risk.

Napier et al suggest regulatory measures for the removal and use of materials with leaded paint and stricter processes for determining how hazardous material is. Decontamination procedures and labeling requirements also need to be reexamined. Materials that are subject to direct contact might require different labeling that those that are inclosed in other materials (Napier et al 2005). Overall, incentives should be provided for decontaminating salvageable materials and safely

disposing of hazardous ones. The implications to the bioenergy industry mentioned in previous sections are that burning lead paint is extremely dangerous to human health. Unless wood is properly decontaminated, it is not useful for much of anything. Decontamination of previous generations' (and current generations) toxic materials will be a significant barrier to a large scale salvaging operation. In California, wood will not be accepted at a recycling or salvage facility if it contains over a certain percentage of lead. It is the obligation of the person bringing the wood to test the wood for hazardous levels of paint. Lead testing kits are available for purchase and are inexpensive. If the structure was built before 1978 there is a high potential for lead paint. If the structure was built before 1960, not only is there a high potential for lead paint, but this paint has a higher lead content than paint made in later years (CalRecycle 2017). While this sounds like a significant barrier, if the paint can be removed and no lead can be detected in the wood, this wood is suitable for reuse.

California Zoning Laws

Zoning laws simultaneously be one of the greatest hindrances to green building but also one of the greatest encouragers to green building, depending on the circumstances. The overall goals of zoning are either safety, environmental or aesthetically based (Calder 2017). While most will not argue against having safety and environmental zoning laws in place, aesthetically base zoning laws can be especially problematic because they can effectively ban certain building techniques

or styles and prevent mixed use developments that are developed for both single and multifamily housing solely because they might not be popular. This illustrates the issues surrounding local control of affordable housing. As an idea, most are in favor of affordable housing but one of the side effects is that it can reduce property values in certain areas by increasing the overall supply of housing (Calder 2017). Developers do not want to build in areas where they will not make adequate profits on their buildings. So, while the population is in favor of affordable/multifamily housing they do not want it anywhere near where it could affect property values.

This can be especially problematic in major population centers of California like San Francisco and San Jose where employment opportunities are high, but housing is so expensive that those who work there can not afford to live there. The term NIMBY (not in my back yard) can be used to describe those who seemingly desire affordable housing for everyone but only if it does not lower property values, inconvenience them in anyway or create aesthetic issues. While removing local control could potentially solve many of these issues, federal housing funds can not always be used in that fashion. Inclusionary zoning practices can also have an adverse effect of driving away builders, creating a worse housing crisis (Calder 2017).

While the simple answer to solving the housing crisis is to build more housing of a variety of types in areas where employment is likely and public transportation is available, this is not always possible due to micro political issues.

Environmental Gentrification

Environmental gentrification is a difficult topic to describe, partially because it involves the seemingly contrary ideas of environmentally friendly design and classism/racism. It is possible and highly likely for environmentally friendly design to be used to make an area more appealing to wealthy investors, when said design was originally intended to improve the lives of the current residents. This can lead to rent increases that can price current residents out of their living spaces. Building parks, walkable streets, providing efficient public transportation and efficient buildings has benefits for everyone who currently lives in an area. However, many environmentally conscious features also have significant marketing influence. This, coupled with cost, can raise the prices of construction which can raise rents and price long term residents from their homes (Smith 2019). If designing cities in an environmentally friendly way is supposed to benefit humanity, environmental gentrification should be avoided at all costs. Technology that is supposed to improve the standard of living for residents should not be used as a weapon of discrimination. Environmental gentrification calls into question one of the most important aspects of sustainability, which is equality. One of the most difficult tasks in determining sustainability is whether something is sustainable for everyone. The issue with environmental gentrification is that it counteracts the original purpose of the improvements, which was to improve the standard of living for the current residents and revitalize the area.

Where NIMBYism, Environmental Gentrification and Green Construction Collide: San Francisco California

San Francisco is currently one of the most turbulent housing markets in the United States. The median rent for a one bedroom apartment is $3600. The median home value is $1,362,000 (Zillow 2019). Most of this turbulence was caused by the influx of money entering the city due to the technology industry creating newer and higher paying jobs. San Francisco is also in the center of the "green bubble[1]". Despite the environmental regulations that require green building practices are followed to a certain degree, severe market pressure forces builders to conduct themselves in an environmentally friendly fashion because being environmentally friendly is a selling feature. The influx of tech money coupled with other political pressures has led to a level of gentrification in the city. In general, everyone acknowledges the housing shortage in San Francisco as evidenced by the high rent (Hankinson 2018). However, where this housing is being constructed is a large issue because many of the housing options geared towards tech workers are being built in lower income neighborhoods, driving up the price of rents as improvements are being made or owners take rental properties off the market and convert them to owned properties. While 75% of the apartments in San Francisco are rent controlled, under the Ellis Act, property managers can still convert rental units to ownership units and effectively force residents out (Hankinson 2018). This becomes an attractive option in an area that is rapidly gentrifying due to new money flowing in. Just like a healthy ecosystem needs biodiversity to function, a healthy city needs economic diversity to function. The irony of San Francisco labeling itself as a

[1] This term was taken from the GreenerBuilder conference. It was used heavily by Bay Area professionals when describing the contrast between their local areas and other parts of California.

sustainable city is that two of the key pillars of sustainability are social and economic sustainability which a rapidly gentrifying city struggles to illustrate. A prime example of where the concepts of sustainability, environmental gentrification and NIMBYism collide is the Hunter's Point/Bayview revitalization project. Historically, this area of San Francisco has been a railyard and an area dominated by slaughterhouses. The navy also stored ships used in nuclear testing in the area as well. Most of the inhabitants were minorities. The navy is now cleaning up the radioactive waste and the area will be zoned for luxury, LEED certified condominiums that are out of the range of affordability for the average resident of the neighborhood (Dillion 2018). The least expensive units available retail for $600,000 and are 600 square feet. The neighborhood further markets itself as a place for innovators and tech workers, a direct indication of the type of person they want to inhabit the neighborhood (Lennar 2019). Bayview is a predominantly African American neighborhood deeply rooted in social justice issues and self advocacy. In 2006 when the redevelopment began and radioactive dust mitigation started, residents quickly raised concern over the demolition and cleanup methods. While the method being used for demolition and cleanup of waste was the least expensive and fastest, it was carried greater health risks because more contamination was exposed to the open air (Dillion 2018). In 2013 and 2016, lawsuits were filed against the company Tetra Tech for falsifying soils tests that lead developers to believe the soil was less toxic than previously thought. By July 2018, nearly 40,000 Bayview residents joined a class action lawsuit against Tetra Tech for the fraudulent soils test (Norman 2018). Incidents like this illustrate exactly how complicated environmental gentrification can be. In this case, a wealthy developer is building luxury housing and petitions for the cleanup of toxic waste, which is something the residents had tried to accomplish and

failed. The residents knew of the dangers and raised their concerns, which were ignored at first. Only when it was discovered that testing was falsified did the development come under more scrutiny about its potential effects to the local neighborhood and this was viewed through the lense of who the new housing was designed for, not the longtime Bayview residents. These factors also illustrate the racial and economic parity that can exist with NIMBYism. Bayview has been home to roughly one fifth of San Francisco's African American population for nearly 100 years. The area was also predominantly blue collar until very recently. Environmental clean up efforts did not begin until luxury housing was slated to be built upon completion, housing these residents could not afford and would most likely create market pressure that would cause their rents to increase. Ironically, a 200 bed homeless shelter is slated to be built in Bayview, which holds 29% of the city's homeless population. Wealthy Bayview residents and developers are extremely critical of the shelter's construction worrying that in addition to crime, it will devalue their properties (Fracassa 2019). The opposition was so fierce that residents began a GoFundMe page to block the construction of the shelter and raise the funds for the legal battle that will ensue. The Tech industry, who were in favor of other forms of housing, were also incredibly resistant to homeless shelters being constructed in Bayview (Holder 2019). Overall, the housing climate in Bayview illustrates how NIMBYism and politics can be used as a guise for environmentalism with the goal of exclusionary politics. This is the exact opposite of what true sustainable housing aims to achieve.

Recommendations and Conclusions

This recommendations list was partially created by shadowing housing developers and hearing their concerns related to costs, profitability and zoning restrictions. While these recommendations are grouped into three separate types, they are not mutually exclusive. The general public, the government and housing developers do not operate in a vacuum and they respective groups' decisions affect each other.

General (Public)[2]

1. Build more high density housing near transportation centers.
2. Reimagine the single family home. A cultural shift is needed.[3]
3. Realize that society needs strong, economically diverse communities[4].

For Government

1. Revamp zoning laws to exclude policies that could foster race/social class issues.[5]
2. Create high density, affordable housing for everyone.
3. Create and foster systems that encourage "YIMBY" activity.

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[2] Generally, these solutions were based off of the scenario presented in my analysis of the current environmental gentrification situation in San Francisco.

[3] Oftentimes, the ideals of home ownership gravitate towards large, free standing homes and de-incentivize the density bonuses made to create more abundant and less environmentally costly housing.

[4] One of the themes of Rebuild Green Expo was strengthening the economy of Santa Rosa after the economic devastation caused by the 2017 fire.

[5] This recommendation is designed to prevent the situation presented in my description of Hunter's Point.

For Business (Proceedings from GreenerBuilder 2019)[6]

1. Realize that business plays a part of the problem and can also be part of the solution.
2. Invest in communities[7].
3. Build high density and green.
4. Understand the political influences that go into making business decisions.
5. Be more receptive to green technology and take advantage of government/private programs designed to foster its adoption. [8]
6. Be responsible when it comes to designing products and be aware of disposal impacts.

Many of these solutions revolve around cultural and value shifts. While green building is seen as a profitable marketing ploy, that can often be were its adoption stops. In diluting green building in this manner, the true purpose and benefits of the technologies are lost and it becomes less trusted and less reliable leading to its disuse. It is up to governments, businesses and consumers to work together and make green building technology an economically and socially viable solution. However, questions still remain as to whether business interests will out rule needed action until it is too late to make the needed changes to provide a society for the nearly 9 billion

[6] This specific list was heavily influenced by solutions presented at the GreenerBuilder conference in San Francisco.
[7] This recommendation was influenced not only in conversations with builders but also observations from Rebuild 2019 (NCA Builders, 2018-2019; Rebuild 2019).
[8] Solutions 4 and 5 were developed by not only by conference proceedings by also with conversations with local California builders (NCA Builders, 2018-2019).

people that will inhabit the earth by 2050. Unless the planet, society and the economy are viewed as an ecosystem instead of competing interests, humanity will not solve the resource equity problems it will face in the coming decades.

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Figure 5 Seeno Features List

(https://www.discoveryhomes.cohttps://www.discoveryhomes.com/fairfield-ca/ariam/fairfield-ca/aria)