



SUSTAINABLE REAL ESTATE

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TRADEMARK

 The University of Texas at Austin
Global Sustainability
Leadership Institute

Strategic Recommendations for
Incorporating Sustainability in
Multifamily Housing

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Trademark Property Company is a Fort Worth-based commercial real estate firm that invests in the development of retail, office, multifamily, and mixed-use properties. Trademark creates value as a value-add operator and by listening to all stakeholders in a project.

Trademark is seeking to continue development in multifamily space, which it expanded to in 2021, specifically into sustainable multifamily projects that incorporate ESG in their development. Trademark aims to develop ESG and sustainably focused multifamily developments that not only qualify as NGBS certified and LEED bronze, but also bring monetary value to Trademark. With many green features in multifamily developments increasing upfront costs of development, there needs to be a viable economic benefit within a short-term, 5-year time horizon for Trademark to include these green features in future developments.

For purposes of this white paper, green features will be examined from three lenses that will be of most relevance to Trademark when it comes to establishing features of the highest value to the company. Green features will be looked at from the value to Trademark's investors, value to tenants at the multifamily property, and value to the environment, sustainability, and in relation to green certifications like NGBS and LEED. Note that in the environmental lens, all calculations of NGBS certifications in for points earned from features listed are estimates as points can change based on a variety of factors. These estimates were determined using the 202-2021 NGBS points sheet for multi family properties.

First, the white paper will dive into the customer analysis of Trademark's ideal tenant when it comes to tenants in multifamily sustainable development and a brief introduction to NGBS and LEED. Then, a discussion and analysis of six key green features that we believe Trademark would gain the greatest value out of. Following this, a recommendation of the top three features as they relate to the lenses specified above.

CUSTOMER ANALYSIS

In the past, concerns with sustainability have not been the main focus for property owners and tenants. But as the effects of climate change become more prevalent in daily life, efforts towards sustainability are becoming a great priority for investors, tenants, and developers, especially since the targeted renting group is shifting to a more environmentally conscious generation. As a result, properties that incorporate environmentally conscious designs have more value and greater tenant retention than their older counterparts. Though it is clear that “going green” will add value to a property, it is important to look into whether or not it is enough to justify the cost of going through with these initiatives. The value that a property gains from incorporating environmentally-conscious design is measured by the resulting value from achieving green certifications such as Leadership in Energy and Environmental Design (LEED) and National Green Building Standard (NGBS). This section will look into the value of any general Green Certification for the average consumer and investor, the most cost-effective certifications to pursue by comparing what is required to achieve key certifications of Trademark's interest (LEED Certified and NGBS Bronze), as well as how holding these certifications benefit future proofing efforts in multifamily developments.

Ideal Consumer

As the target market for multifamily shifts towards Millennials and Gen Z population groups, who are more informed about the effects of climate change and efforts towards sustainability, multifamily development must also actively work towards fulfilling demand. According to a survey conducted by First Insight 62% of Gen Z and millennials prefer more sustainable brands and this figure is only expected to grow.¹ The millennial generation, who currently make up the biggest cohort of renters within multifamily homes, have grown up with a heightened awareness of climate change and sustainability, greatly understanding its importance.⁵ These renters both want and expect sustainable accommodation options.

However, in markets where rent affordability is an issue, renters will be less inclined to pay extra for the privilege of living in sustainable multifamilies unless significant cost savings can be generated from reduced utility bills.⁵ Being able to select the right features that achieve this while meeting certification requirements would be invaluable, but it is highly unlikely that existing features have become so efficient. In later sections, this option can be explored when discussing certain features in detail. Nonetheless, it is better to focus on locations where supply and demand for multifamilies are already in broad equilibrium. Property developers can derive the most value from green certifications in such areas since it allows for the opportunity to raise rent and increase occupancy rates. It has already been proven in many studies that certifications such as LEED have raised rent, resulted in lower vacancy than non-LEED structures post-pandemic, and attracted tenants who are more resilient to economic downturn.¹ ESG (Environmental, Social, & Corporate Governance) efforts overall resulted in an 11% premium in rents.¹ In ideal economic conditions, property owners benefit from

increasing rents while tenants are able to satisfy their own ESG obligations.

As for what certifications attract consumers the most, LEED carries more name recognition than NGBS, however, certifications in general are more valued by developers and investors rather than tenants. Tenants are more influenced by the cost of rent and how well a home can promote their health and wellbeing.⁵ In this case, certification name does not matter much unless one certification substantially advocates for tenant interest more than the other which neither do. Local certifications may also add more value to a property if they have strong local market recognition.⁸ Such certifications from a tenant perspective may appear more credible or have more recognition than NGBS or LEED. It is likely that the criteria for NGBS or LEED already cover a majority of the requirements for local certifications so achieving local certifications in addition to NGBS or LEED may also be beneficial depending on local interest.⁶

It is also important to note that in the ESG framework, multifamily owners should prioritize the social aspect to make their properties the most competitive among potential tenants.⁵ If the environmental aspect is already fulfilled by certifications and local regulations in competing properties, the social aspect is where property owners have the most room to distinguish themselves in the market. Fulfilling social requirements may be more difficult than environmental requirements but there is overlap since social responsibility is heavily focused on improving quality of life for tenants which is what many green features that count towards green

certification. Both NGBS and LEED have criteria that require multifamilies to have easy access to sustainable transportation and features that promote tenant health like proper ventilation, good air quality, good thermal health, etc..⁹ Specifically, features that promote health and wellbeing can reduce vacancy which combats the slight vacancy cost associated with rent premiums from incorporating green features.¹

NGBS VS LEED

Both LEED and NGBS are reputable green certifications that investors and consumers trust and both have been shown to raise rent premiums. However, depending on a property owner's needs, one certification is better than the other. These certifications mainly differ in terms of cost, environmental benefit, and meeting local regulations, but they also share many similarities in other aspects that may overshadow the differences. This section investigates these differences and determines which is best for Trademark's interests.

Administrative Costs

Both certifications require additional registration and administrative fees before a property can even be evaluated, but LEED is more costly. NGBS was designed with affordability in mind with less administrative burdens compared to LEED.³ Performing a simple cost analysis will reveal that getting NGBS certifications is much more affordable than obtaining LEED certification. For a new, mid-level, 5 story, 20 unit multifamily complex, the process of obtaining LEED Certified would cost Trademark a minimum of \$2,130 excluding credit fees.⁴ For NGBS certification, Trademark would only have to pay a minimum of \$1,300.⁶ LEED certification does allow more flexibility in getting points for features unlike NGBS, but it does cost more in forms of additional credit and expedited review fees.⁴ While this can make the process of certification easier overall, it can hurt the credibility of a property because paying these additional fees may be perceived as cutting corners in order to obtain green certification which reflects poorly on potential tenants and investors if they are knowledgeable on the subject.

Fig. 1 - LEED Administrative Fees

| Multifamily (per building) | | |
|--|----------------------|----------------------|
| Registration | \$900 | \$1,200 |
| Certification (0-49 Units) | \$0.035 per sf | \$0.045 per sf |
| Certification (>50 Units) | \$0.030 per sf | \$0.040 per sf |
| Expedited review (reduce from 20-25 business days to 10-12, available based on GBCI review capacity) | \$10,000 per project | \$10,000 per project |
| Appeals: Complex credits | \$800 per credit | |
| Appeals: Credits | \$500 per credit | |
| Appeals: Expedited review | \$500 per credit | |
| Formal Inquiries | | |
| Project CIRs | \$220 per credit | |

The minimum fees Trademark would have to pay for LEED certification assumes that each unit is 1,035 sqft (median unit size in the U.S.) and that the multifamily complex is five stories and has 20 units. The calculated value of \$2,130 does not include expedited review, appeals, or formal inquiries.⁴

NGBS VS LEED

Fig. 2- NGBS Administrative Fees

| MULTIFAMILY BUILDINGS OR RESIDENTIAL PORTION OF MIXED-USE BUILDINGS ^b | | |
|--|--|--------------------------------------|
| Registration | Free | |
| New Construction or Existing Buildings | Up to 3 stories | \$300 per building + \$30 per unit |
| | 4 stories to 8 stories | \$700 per building + \$30 per unit |
| | 9 stories and above | \$1,000 per building + \$30 per unit |
| | MF Volume Pricing (10-19 bldgs) ^b | \$200 per building + \$30 per unit |
| | MF Volume Pricing (20-49 bldgs) ^b | \$150 per building + \$30 per unit |
| | MF Volume Pricing (50+ bldgs) ^b | \$125 per building + \$30 per unit |
| b. To be eligible for volume discounts for MF buildings, buildings must be on the same development parcel within the same community. | | |

The minimum fees Trademark would have to pay for NGBS certification assumes that each unit is 1,035 sqft (median unit size in the U.S.) and that the multifamily complex is five stories and has 20 units. The calculated value of \$1,300 does not consider volume pricing.⁶

Environmental Regulations

Both LEED and NGBS help promote green building innovations and help properties meet housing policy goals and regulations but LEED is slightly more flexible than NGBS in terms of getting points to qualify for the minimum certification. With LEED, buildings may attain points in any category to achieve the total points required for a given certification level and does not require point minimums in every category of the green building rating.⁴ In order to achieve NGBS certifications, all projects must achieve a minimum point threshold in every category. It is the only national program with this level of cross-category stringency, making it the most rigorous and comprehensive green building rating system.³ NGBS also requires two on-site inspections.⁶ It makes sense that NGBS is ANSI certified while LEED is not, making it the more credible certification from the perspective of environmental responsibility.⁶ To be recognized by the American National Standards means that the NGBS has undergone thorough public review and has met the requirements of a true consensus standard.³

Because of LEED's flexibility to meet certification requirements, some properties who have utilized their certification system have been accused of greenwashing. For example, The Palazzo at The Venetian Resort in Las Vegas achieved LEED certification in 2008, becoming the first Las Vegas resort to receive LEED Silver Certification.¹⁰ However, The Palazzo was only able to achieve LEED certification due to strategic points stacking by installing features that are not as impactful but still count the same like bike racks and unnecessary IoT upgrades. The Palazzo was able to score "easy" points

towards LEED certification. This concept of gaming the LEED points system is not uncommon. Many properties have obtained most of their points in categories that they consider easier to achieve. USA Today examined 7,100 LEED-certified commercial buildings and found that designers "target the easiest and cheapest green points."¹⁰ But this may be ideal, if it is done strategically making LEED certification actually cheaper to obtain than NGBS because of its flexibility to allow property owners to install cheaper features that count for the same points.

NGBS is more flexible for helping architects and developers recognize regional regulations and priorities because of its more expansive system. For example, NGBS has a category for building operation, maintenance, and building owner education while LEED has no equivalent categories.³ This allows for more opportunities to meet requirements for governmental benefits as well such as tax breaks and regulations at the least. For Trademark's interests, if a multifamily that obtained LEED Certified were to be built in Texas, the building could qualify for the Qualified Allocation Plan for Low-Income Housing Tax Credits which awards up to 4 points for certification.⁶ But if the building was NGBS Bronze, it could qualify for those benefits as well and meet the Dallas Green Building Ordinance which considers NGBS compliance as an acceptable method to meet green building requirements.⁶ But for most policies, both LEED and NGBS

NGBS VS LEED

are accepted. The NGBS certification also meets the requirements for the benefits from the Qualified Allocation Plan in many states, however, for some states like California, a minimum of NGBS or LEED Silver may be necessary for meeting any regulations or benefits.⁶

Investor and Tenant Recognition

For investors and tenants, neither certification really stands out more than the other, but the LEED system has been around longer than NGBS.⁴ More properties have LEED certification than NGBS and are more recognizable as a result, but with NGBS's more rigorous requirements, its certifications may hold more credibility in the near future. But for now, neither certification has significantly more recognition than the other and either work to fulfill investor and tenant interest.⁷

Recommendation for Trademark and Future Proofing

The best certification for Trademark's interest is NGBS Bronze rather than LEED Certified in not only cost and environmental credibility, but also for the purposes of future proofing within a 5-year horizon. For current interests, either work to satisfy ESG concerns for both investors and tenants since there is no perceived difference between the two certifications among the general public. But for administrative and registration costs, NGBS is the better certification system. For the cost of incorporating features to meet certification requirements, LEED allows for more flexibility. However, to keep future proofing goals in mind, taking advantage of this flexibility may not be the best option. As more environmental issues arise, policymakers are taking more initiative to pass regulations to help reduce the effects of climate change which may change the real estate industry, even in the short-term. Incorporating features that meet a higher sustainability standard now can be invaluable for the short-term because if more regulations do get past and the features previously installed do not meet those regulations, more costs may be incurred to make the necessary adjustments. The NGBS system is more stringent and will reduce the chances of this occurring. Many of the features that meet NGBS requirements also increase the resiliency of a building which can reduce future maintenance costs as well. Tenant satisfaction will likely be greater as well because of higher quality features that not only meet sustainability concerns but also improve occupant comfort and wellbeing, helping to keep rent premiums up and increase tenant retention. Under these considerations, the LEED system is outdated and has more room for improvement. For the short term and even the long term, NGBS certification is the better option.

NGBS: Difference Between the Levels

There are four levels of certification available: Bronze, Silver, Gold, and Emerald. Bronze requires the least amount of points to achieve.⁶ In order to be considered for certification, buildings must demonstrate high-performance in the following areas: Lot Design and Development, Resource Efficiency, Water Efficiency, Energy Efficiency, Indoor Environmental Quality, and Building Operation & Maintenance.⁶ The program also offers certification for land development for residential communities which is independent of certification of residential buildings. Each category is listed as a chapter on a spreadsheet with features that can be marked off whenever a requirement is met.⁶ For each category, a certain number of points must be met in order to achieve a certain level of certification. For Trademark, a multifamily would need to accumulate 181 points to qualify for NGBS Bronze.

NGBS VS LEED

Fig. 3- Summary of NGBS Point Requirements

| Categories | Bronze | Silver | Gold | Emerald |
|----------------------------------|--------|--------|------|---------|
| Lot Design and Development | 50 | 64 | 93 | 121 |
| Resource Efficiency | 43 | 59 | 89 | 119 |
| Water Efficiency | 25 | 25 | 25 | 25 |
| Energy Efficiency | 30 | 45 | 60 | 60 |
| Indoor Environmental Quality | 25 | 42 | 69 | 97 |
| Building Operation & Maintenance | 8 | 10 | 11 | 12 |
| Total | 181 | 245 | 347 | 428 |

Here is a summary of the required points for each category with respect for each level from their 2020 scorecard.⁶

INTERNET OF THINGS

The internet of things, also known as IoT, is a network of physical devices that are embedded with sensors and software that connect and exchange data with other devices over the internet. Today there are over 14 billion connected IoT devices, and by 2025 this number is expected to grow to 22 billion.^{11,12} These devices can be utilized in a multitude of industries and have a wide range of complexity. From household objects to sophisticated industrial tools, IoT devices can monitor, track, and adjust each interaction between smart devices.¹³

Specifically in real-estate, possible applications for IoT devices include thermostats, water and electrical systems, kitchen and bathroom appliances, home security, air-filtration systems, and smoke detectors. However, advances in connected devices do not come without drawbacks. Internet access and high speeds are critical to the success of IoT. Additionally, because these devices are connected to the internet, households become vulnerable to cybersecurity attacks. Therefore, a highly connected framework and careful selection of devices are necessary.

Investors

Smart home technologies have been shown to give property owners an advantage in the rental market. This suggests that these properties will have increased tenant demand and retention. IoT devices in the home have been shown to be favorable among millennial renters in particular. A study done by PointCentral, which surveyed 1,500 renters in 2021, found that nearly 70% of renters would pay an additional \$10-\$20 a month for smart features.¹³ A similar study done by Wakefield Research found that millennials are specifically willing to pay more for smart security devices such as high-tech door locks.¹³

However, smart devices require a larger initial investment in the early stages of property development. According to Home Advisor, a website for connecting homeowners with local service professionals, the average cost of implementing a basic IoT feature ranges from \$300-\$3,000, but the total cost of a solution can range widely depending on the number of smart features included.¹⁵ Due to the high upfront costs, starting with a few impactful IoT systems, namely a smart system and a smart thermostat, is likely the best route for new developments. As IoT becomes more popular and accessible, building new multifamily properties with sufficient network connection to support IoT and a few smart devices will help future-proof the property.

INTERNET OF THINGS

Fig. 4- Average cost and examples for home automation types, done by Home Advisor. 15

| Smart Home Type | Average Cost Range | Common Examples |
|-----------------------------|-----------------------------------|---|
| DIY tech | \$100 – \$3,000 one-time purchase | Google Nest; Ring; Amazon Alexa and Blink; SimpliSafe |
| Subscription-based | \$500 – \$1,500 per year | ADT; Vivint |
| Custom installs and systems | \$2,000 – \$150,000 total | Savant; Elan |

Fig. 5- Average cost for home automation devices, done by Home Advisor. 15

| Home Automation Function | Average Cost Range (All-in) | Average Cost (All-in) |
|--------------------------|-----------------------------|-----------------------|
| Home entertainment | \$30 – \$2,000 | \$1,020 |
| Security | \$700 – \$5,000 | \$2,850 |
| Thermostat | \$800 – \$2,000 | \$1,400 |
| Lighting | \$1,000 – \$3,000 | \$2,000 |
| Power usage | \$1,130 – \$3,750 | \$2,440 |
| Lawn and garden | \$200 – \$500 | \$350 |

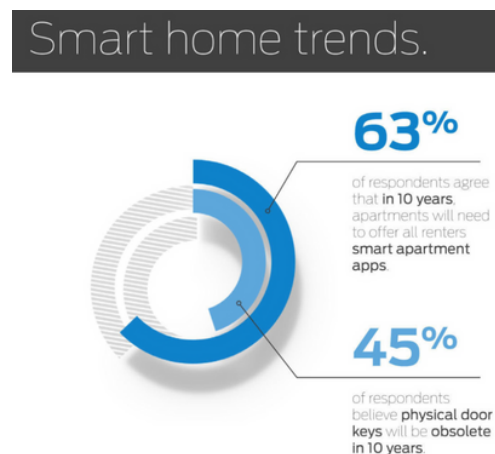
INTERNET OF THINGS

Fig. 6- Average cost and examples for home automation types, done by Home Advisor. 15



Trends for tenant preferences indicate that consumers expect smart apartments and homes to become a part of future homes. In addition to the safety features smart devices can provide, thermostat systems are a popular smart home addition. After reviewing a few different smart thermostat systems, US customers were found to have saved on their heating and cooling expenses. For example, the Nest thermostat savings for customers ranged from 10-12% on heating bills and about 15% on cooling bills.¹⁶ For the ENERGY STAR smart thermostat, savings for customers were about 8% of heating and cooling bills.¹⁷ Depending on the climate, consumer comfort preferences, and HVAC equipment, savings may fluctuate. Smart thermostats and other IoT devices that manage energy and water consumption are key features that can allow tenants to save on their bills and ultimately draw tenants to the property. IoT devices that provide predictive maintenance are an added benefit for tenants. Because maintenance issues will be detected early, the damage between units is minimized, resulting in an optimal tenant experience.

Fig. 7- Average cost for home automation devices, done by Home Advisor. 15



Environment

Various IoT devices provide capabilities to monitor and reduce energy consumption. Reducing energy consumption is an important step to reducing carbon footprints and creating a more sustainable lifestyle. A study done in Finland found that home automation, including IoT devices and a smart grid, could reduce carbon emission by 12.7 %.¹⁸ The NGBS certification allocates points for smart features that can mitigate the amount of energy used by consumers. The NGBS certification also strives to minimize CO2 emissions and therefore awards a multitude of points to buildings that leave a small carbon footprint. IoT devices allow tenants to use energy in the most efficient manner possible, which helps protect the environment while providing cost savings due to reduced energy consumption. The chart below outlines potential NGBS points awarded for smart device systems.

INTERNET OF THINGS

Fig. 8- Chart that outlines potential NGBS points awarded for smart device systems³⁰

| Practice Number | Feature | Maximum Points |
|-----------------|---|--|
| 705.2.1 | Indoor/Outdoor Lighting Sensors | 11 pts |
| 706.1 | Energy Consumption Control | 3 pts |
| 706.3 | Smart Appliances | 2 pts |
| 706.4.2 | Pumps | 5 pts |
| 706.7 | Grid-Interactive Electric Thermal Storage System | 2 pts |
| 706.10 | Automatic Demand Response (curtails energy usage upon a signal from utility provider) | 1 pt - if points are awarded, points shall not be awarded in 706.3 and 706.7 |
| 706.12 | Smart Ventilation | 1 pt |
| 802.3 | Water Usage Metering for Multifamily Buildings | 8 pts |
| 803.3 | Automatic Leak Detection and Control Devices | 2 pts |
| 802.6.4 | Smart Controller for Irrigation System | 10 pts |
| 802.6.5 | Flow Sensing Device for Irrigation System | 3 pts |

MASS TIMBER

Investors

Overall, the cost of mass timber is expected to be comparable to other building materials like concrete, depending on factors such as where the wood is sourced. The material itself is more expensive, but it is much quicker to build with. A study comparing concrete to mass timber illustrates that mass timber is approximately 6.43% more expensive. However, savings can be found if reviewing the construction project as a whole. For example, Lendlease, a large international developer, completed a four-story CLT military hotel in Alabama 37% faster and used 43% fewer construction workers than a comparable metal stud building.¹⁹ Another example includes the Class A 1 De Haro building. The director of the development project said the 58 feet tall building “went up so quickly; we saved about four months in construction time and the wood helped [us] to limit the weight that concrete would have put on the foundation.”²² Quicker building times and fewer construction workers result in a reduction in building costs that help help compensate for the more expensive material.

Additionally, developers can mitigate finishing costs by leaving areas of the timber exposed, which results in a beautiful, natural design. Mass timber developments have also seen more interest from tenants, which increases tenant retention and stabilizes cash flows. Mike Heller, a developer from Heller Pacific, found that their office building made of heavy timber in California “sold itself because of its unique character”, which was fully leased in less than six months.¹⁹

Tenants

Mass timber offers a unique, sustainable option to tenants interested in sustainable developments. However, mass timber does not only appeal to those committed to the environment. The material is noted to be aesthetically pleasing, and research illustrates that wooden features improve quality of life. The exposed wood on mass timber properties provides a unique feel to a space that tenants are interested in, proven by increased leasing velocity. In a study done in Australia, over 1,000 employees were sampled and discovered that wooden features contribute to higher levels of employee satisfaction.²³ The participants of the study identified wood as a natural material that is both relaxing, enjoyable, and promotes wellness.²³ They also reported better concentration, more optimism, less stress, and greater productivity.²³ Although the study was done in an office setting, the emotional and psychological response to wood would likely be comparable to a home environment. Moreover, as the workplace becomes more hybrid, it becomes more important to build a space conducive to both home and workplace lifestyles. Mass timber is a building material that can provide aesthetics, functionality, and health benefits to tenants.

Environment

Mass timber has a much lower impact on the environment than other building materials. A study done in Chile, assessing the carbon emission footprint of using mass timber products for residential buildings found that from cradle-to-construction, the embodied emissions of the mass-timber building were 42% lower than those of the equivalent concrete building.²⁴ Wood continues to store carbon absorbed by the trees while growing, keeping it out of the atmosphere for the lifetime of the building. Wood products typically require less embodied energy to manufacture than other building materials, and most of that comes from renewable biomass (e.g., bark and other residual fiber) instead of fossil fuels.¹⁹ Life cycle assessment studies consistently illustrate that wood outperforms other materials, such as concrete and steel.¹⁹ A mass timber residential building is a tangible way to illustrate the developer’s alignment with ESG goals, due to its green qualities.¹⁹ The chart below outlines NGBS points awarded for mass timber features.

MASS TIMBER

Fig. 9- Chart that outlines potential NGBS points awarded for mass timber³⁰

| Practice Number | Feature | Maximum Points |
|-----------------|------------------------------|----------------|
| 601.7 | Prefinished Materials | 12 pts |
| 606.1 | Biobased Products | 8 pts |
| 606.2 | Wood-Based Products | 7 pts |
| 608.2 | Resource Efficient Materials | 9 pts |
| 703.2.2 | Mass Walls | 3 pts |

GREEN CONCRETE

“Green concrete” also known as environmentally friendly concrete is the same as normal concrete except it is manufactured using waste or residual materials from different industries.²⁵ As a result, green concrete is more cost-efficient, energy efficient, and environmentally friendly than normal concrete usage in development.²⁵

Investors

There are multiple benefits to using green concrete in a multifamily project from the investor and financial perspective. One important highlight is that green concrete is generally the same price if not slightly cheaper than normal concrete. One green concrete form, ground granulated blast furnace slag (GGBS), when paired with reject (recycled) water improved the strength of concrete produced by 16.5% and can save as much as 170\$–340\$ per cubic meter of green concrete produced.²⁶ Now there will be fluctuations in the pricing of green concrete based on waste materials used and the manufacturing process, but there should not be a large increase or decrease expected if used in multifamily development.²⁷ Green concrete can also potentially yield an increased appreciation of the property over time due to green concrete and other sustainable materials being used in development.²⁶ This potential increase in building appreciation can also be derived from green concrete’s benefit of being more durable and longer lasting than normal concrete, future-proofing development.

Utilizing green concrete as a sustainable material in development illustrates the focus on ESG and sustainability by Trademark as a company in its development. Concrete production is responsible for 5% of global CO2 emissions and this focus on ESG with green concrete bolsters Trademark’s image.²⁸ In addition to the appearance of the property as ESG-focused and increasingly sustainable, this feature combined with other green features to maximize ESG in development could be used to increase rents on the tenant side, benefiting investors and Trademark. However, the availability of green concrete is scarce due to the lack of manufacturers of environmentally friendly concrete, but the availability of this material is increasing with demand as the landscape of real estate development changes to focus more on sustainability. Earlier it was mentioned that green concrete is indeed cheaper than normal concrete, but prices do not always reflect this as green concrete supply is much lower in comparison to normal concrete.

GREEN CONCRETE

Tenants

Benefits of using this green feature on the tenant side of a multifamily development are minimal, but the main benefit is to incur additional ways to market the sustainability of a multifamily property to ESG-conscious tenants.²⁶ One potential benefit for tenants of a property utilizing green concrete is that green concrete offers a slight reduction in energy and utility bills due to green concrete having a slight increase in thermal resistance and thermal efficiency in comparison to normal concrete, resulting in less energy consumption.²⁵

Environment

Environmental benefits for the implementation of green concrete are commensurate to the value brought on the investor and financial side of this implementation. Utilization of green concrete in a multifamily development will be highly beneficial to the acquisition of the NGBS bronze and LEED bronze certifications for the multifamily development. Building materials of development constitute a large sum of points available for the NGBS certification of a project, and utilizing green concrete will claim a lot of these points. Green concrete has slightly increased thermal resistance/efficiency and acid resistance in comparison to normal concrete used in development and as a result, less energy will be consumed for heating and cooling the property.²⁹ Acid resistance will contribute to the future-proofing of the development as environmental conditions constantly change the building's surrounding pH, which can lead to issues in the long run.²⁵ The main benefits from the environmental lens that come from green concrete are that green concrete is environmentally friendly and utilizes substantially less energy for its production in comparison to normal concrete. Green concrete decreases CO2 emissions and helps reduce environmental pollution through its production which utilizes residue waste material.²⁶ It solves the problem of needing recycling and disposal space for industry waste material. In relation to the NGBS certification, there are significant points to be earned through implementing green concrete into a development. The chart below outlines NGBS points awarded for green concrete usage.³⁰

Fig. 10- Chart that outlines potential NGBS points awarded for green concrete usage³⁰

| Practice Number | Feature | Maximum Points |
|-----------------|------------------------------|----------------|
| 601.2 | Material Usage | 9 pts |
| 601.8 | Foundations | 3 pts |
| 602.1.7 | Moisture Control Measures | 2 pts |
| 603.2 | Salvaged Materials | 9 pts |
| 604.1 | Recycled Materials | Mandatory |
| 606.1 | Bio-based Materials | 11 pts |
| 606.3 | Manufacturing Energy | 3 pts |
| 608.1 | Resource-efficient Materials | 3 pts |
| 612.2 | Sustainable Materials | 3 pts |

GREEN ROOFS

Green roofs, also known as vegetated or “living” roofs, are ballasted roofs consisting of a waterproofing membrane, growing medium (soil), and vegetation (plants), overlying a traditional roof.³² Green roofs can take many different forms such as in figure 1 below where the green roof is doubling as a recreational space for tenants.³³ When it comes to green roofs, the fewer floors a building has, the greater the energy savings are for a green roof.³⁴ It is important to note that green roofs do have initial upfront costs that are higher than black roofs and do have a payback period of longer than 5 years.³⁴ In addition, the first years of a green roof's existence are considered an establishment period, in which maintenance is critical to the roof's long-term success which creates additional costs.³⁴

Green roofs on commercial and public buildings provide a payback, based on 50-year average annual savings, of about 6.2 years nationally, an internal rate of return of 5.2%, and an ROI of 224%, based on a net present value of \$2.7/square foot.³³ This illustrates the payback period of green roofs being 6.2 years, which accounts for expenses with maintaining and owning a property and does not factor in the appreciation of the property or rental income increases.³³ An additional benefit of green roofs is the stormwater and energy savings, which over 50 years provide a benefit of approximately \$19 per square foot of roof.³³ Based on a 50-year period, there are total savings of almost \$38 per square foot of roof compared to black roofs, which suggests value in utility.³³

Fig. 11- Image of a green roof in a multifamily development that provides not only the general benefits of green roofs but also doubles as a recreational area for tenants.³³



Investors

Green Roofs do hold value both to investors and to Trademark from a financial perspective. Things to initially consider are the upfront costs of green roofs in comparison to the industry standard. Green roof costs range from \$10.30 to \$12.50 per square foot more compared to a conventional, black roof.³⁴ In addition to this, the installed cost premium ranges from \$16.20 to \$19.70 per square foot more compared to a conventional roof.³⁴ In addition to these upfront costs, the annual maintenance for a green roof is typically higher than for a black roof, by \$0.21 to \$0.31 per square foot. It is important to note, however, that green roof installation costs per square foot decrease as the size of the roofing increases.³⁵ Below is the cost-benefit analysis of Green roofs compared to conventional, black roofs, done by the U.S. General Services Administration.

GREEN ROOFS

Fig. 12- Cost-benefit analysis comparing Green roofs to conventional roofing, done by the U.S. General Services Administration³³

Table 8: Cost-benefit analysis results of green roof vs black roofs

| NATIONAL LEVEL RESULTS | ROOF SIZE (ft ²) | | |
|--|------------------------------|---------|---------|
| | 5,000 | 10,000 | 50,000 |
| Impact on Owners/Occupants/Investors | | | |
| Initial Premium, \$/ft² of roof (extra cost of installing a green roof instead of a black roof) | -\$12.6 | -\$11.4 | -\$9.7 |
| NPV of Installation, Replacement, & Maintenance, \$/ft² of roof | -\$18.2 | -\$17.7 | -\$17.0 |
| NPV of Stormwater, \$/ft² of roof (savings from reduced infrastructure improvements and/or stormwater fees) | \$14.1 | \$13.6 | \$13.2 |
| NPV of Energy, \$/ft² of roof (energy savings from cooling and heating) | \$6.6 | \$6.8 | \$8.2 |
| Net Present Value (installation, replacement & maintenance + stormwater + energy NPV) | \$2.5 | \$2.7 | \$4.5 |
| Internal Rate of Return (IRR) | 5.0% | 5.2% | 5.9% |
| Payback, years | 6.4 | 6.2 | 5.6 |
| Return on Investment (ROI) | 220% | 224% | 247% |
| Other Financial Impacts (less realizable) | | | |
| NPV of CO₂e, \$/ft² of roof (emissions, sequestration & absorption) | \$2.1 | \$2.1 | \$2.1 |
| NPV of Real Estate Effect, \$/ft² of roof (value, rent, absorption & vacancy) | \$120.1 | \$111.3 | \$99.1 |
| NPV of Community Benefits, \$/ft² of roof (biodiversity, air quality, heat island, etc.) | \$30.4 | \$30.4 | \$30.4 |

Now when it comes to the financial benefits of green roofs, green roofs can extend the lifespan of a roof by over 200% by covering the waterproofing membrane with growing medium and vegetation, which shields the membrane from ultraviolet radiation and physical damage; this goes in hand with future-proofing and can result in the reduction of long term roofing maintenance costs and roof replacement.³⁵ In addition to this, a green roof will increase the appreciation and property value of the development by an average of 7% which can offset the upfront costs.³⁵ In addition, green roofs can result in a 26% reduction in summer cooling needs and a 26% reduction in winter heat losses; this benefits both the tenant and property owner through lower utility and energy costs.³⁵ The reduction in the energy requirements of the building year-round allows the building temperature to be controlled at a lower cost. Additional financial benefits from green roofs include potential tax benefits, rebates, stormwater tax reductions, and grants, which are dependent on building location.³⁵ The investor benefits from a financial perspective as there is viability for increased rental rates of a multifamily property utilizing green roofing; aesthetics of the building sharply contrast from other developments in the area, which not only emphasize the sustainability focus of the development but also can account for increased rental rates in the property.

GREEN ROOFS

Tenants

From the tenant perspective, green roofing in a building shows a clear focus on sustainability. This is more apparent through green roofing than through the implementation of other green features, since a green roof is a large, physical representation of the developer's commitment to ESG initiatives. Economically, green roofs benefit tenants since there will be a reduction in energy bills because heating and cooling costs are reduced; green roofs reduce energy needs for air-conditioning by 25% to 80%.³⁶ In addition, the air quality in the surrounding environment is greatly improved due to the green roof. Since a green roof improves the aesthetics of a development, tenants may be more willing to pay increased rent to live in the multifamily development since there are clear benefits aesthetically, financially, and environmentally.

Environment

From an environmental perspective, there are numerous benefits to a green roof. Firstly, green roofs benefit the environment by allowing for stormwater to be displaced better than with normal roofs, which can prevent flooding or incurred damage during heavy rains.³⁴ Green roofs do this by absorbing stormwater directly into the soil.³² In addition, green roofs provide both good thermal resistance and thermal insulation which allows for less energy expenditure for heating and cooling properties.³⁶ This reduces the consumption of energy and the overall carbon footprint of a property. Green roofs benefit the environment and tenants likewise by improving the air quality within the location of a property, which benefits both tenants and the environment. There are also benefits to the NGBS certification for implementing green roofs on a property. The chart below outlines NGBS points awarded for green roof usage.³⁰

Fig. 13- Chart that outlines potential NGBS points awarded for green roof implementation³⁰

| Practice Number | Feature | Maximum Points |
|-----------------|----------------------------|----------------|
| 503.4 | Storm Water Management | 10 pts |
| 503.6 | Wildlife Habitat | 6 pts |
| 505.2 | Heat Island Mitigation | 5 pts |
| 505.10 | Exercise & Recreation Area | 3 pts |
| 602.1.7 | Moisture Control Measures | 2 pts |
| 602.1.12 | Roof Overhangs | 4 pts |
| 602.1.14 | Architectural Features | 2 pts |
| 602.2 | Roof Surfaces | 3 pts |
| 602.3 | Roof Water Discharge | 4 pts |
| 703.7.3 | Passive Cooling | 3 pts |

ELECTRIC VEHICLE STATIONS

Environment

With the progression of climate change, many individuals are concerned with what they are doing to mitigate their own emissions. Individuals have turned to electric vehicles, which offer clean energy and improved performance, as a means of doing so. Traffic is responsible for nearly a quarter of all CO₂ emissions worldwide. Electric vehicles have the capacity to reduce the pace of climate change if batteries and electricity used to power them are completely carbon neutral.

The electric vehicle industry is projected to grow by 23.17% in the next five years.³⁸ In Q2 of 2022, EV sales accounted for 5.6% of the total automotive market.³⁹ There are projected to be 27 million EVs on the road in 2030, and 92 million by 2040.⁴⁰ In addition, government incentives will continue towards the growth of the electric vehicle market. The rapid growth of the electric vehicle market is undeniable.

With these industry shifts in mind, it is important that homes (single and multi-family) are able to accommodate the growing demand for electric vehicles by ensuring their availability at properties in order to attract and retain tenants. Also, the “green” image of the development will seek to attract communities which are more environmentally conscious.

Costs

There are two main costs relating to the installation, maintenance, and operations of electric vehicle charging stations - those are the primary cost factors and the secondary cost factors.

Primary cost factors should be thought of as prerequisites towards EV station installation and in-house charging. EVSE (electric vehicle supply equipment) purchase and installation ranges from \$1000-\$6000 per unit, in addition to permitting and electricity metering costs. Here are some other considerations for in-house EV charging:

- Adequate building wiring electrical capacity
- Sufficient transformer and service capacity
- Distance between electrical service access points and desired charging sites in relation to other construction requirements

Tenants

With an increased amount of electric vehicles on the roads, tenants will need the availability of charging at their residences with chargers that are not only intuitive to use with quick customer service, but that are also back-end managed. EVs at the residential multi-unit level require level 2 charging capability. Charging availability may be determined by measuring how many tenants own electric cars and require charging stations, and making sure all stations are available for as many EVs are home to the multifamily development. Some further considerations for tenant charging are assigned parking, installation of stations in common areas (not ideal but may be necessary), deeded parking, and shared charging units. Electric vehicle chargers pose a thoughtful amenity for residents. The ability to charge at home after work is an amenity that electric vehicle owners will greatly value. In sum, tenants want low-cost charging that is both quick and efficient, while having perceived charging availability.

ELECTRIC VEHICLE STATIONS

Investors

Historically, EV charging has been a high-risk investment, but as further mandates are passed, the EV market has and will continue to be more widespread. Investors will feel more comfortable in this area going forward, but now there is still a risk.

What we do know is that EV charging boost has the ability to boost revenue through both tenant retention and tenant attraction. Tenants will renew their lease if a property is one of the few properties in the area with EV charging capabilities. For the tenant with convenience in mind, having charging at home means everything to them and justifies increased rent. Fundamentally, electric vehicle charging stations act as a way for managers to charge higher rents to those leasing electric cars by means of convenience. Additionally, property managers are actually able to fully recoup the cost of electricity by offering both private and public charging for two different premiums.⁴¹

As an investment for a multifamily property, electric vehicle charging stations are of great value. With that being said, it is also important to think about the community surrounding the property. EV stations will be more useful in Austin as opposed to a Lockhart multifamily property.

Placing EV stations in developments that would benefit from them would act as a means for future proofing for the inevitable rise in electric vehicle use.

Fig. 14- Chart that outlines potential NGBS points awarded for electric vehicle charging station implementation.

| Practice Number | Feature | Maximum Points |
|-----------------|--|----------------|
| 505.6 | Multi-Unit Plug-In Electric Vehicle Charging | 10 pts |
| 706.8 | Electric Vehicle Charging Station (Level 2 or 3) | 2 pts |

GEOHERMAL HEAT PUMPS (HVAC)

Environment

Geothermal heat pumps use the Earth's consistent internal temperature as an exchange medium as opposed to the temperature of the outside air like a conventional air conditioning unit. In addition to heating and cooling a residence, these systems have the capability to supply hot water. These heat pumps, as compared to air conditioning units, are quieter, last longer, require little maintenance, and don't rely solely upon the outside air conditions.⁴²

An alternative to geothermal heat pumps is dual-source heat pumps which combine air conditioners and traditional geothermal heat pumps. These pumps have higher efficiency than air conditioners, but are not as efficient as traditional geothermal heat pumps. However, the installation costs are much less.

Geothermal heating reduces environmental damage, producing 75-85% less CO₂ than oil and gas producers.⁴³ The ground loops which extract the heat from the Earth are made of high-density polyethylene which lasts 50 years. In addition, geothermal heating voids the fracking process, which is extremely pollutive and natural to the oil and gas extraction process. Other benefits include the elimination of carbon monoxide risk, cheaper heating (after installation payback), and the obsolescence of the boiler and cooling tower utilities.

There are four types of geothermal heat pump systems within two categories defined as: closed and open-loop systems. Closed-loop systems circulate an antifreeze solution through a closed loop and can be horizontal, vertical, or suited for pond/lake. Horizontals are the most cost-effective for residential and are where there is space in the land to place them, while vertical systems are most favorable towards commercial developments where land is a prohibiting factor. A vertical geothermal system would be best for multifamily development in an urban environment. Pond/Lake systems can be placed in bodies of water to save space on land.

Open-loop systems use water underground as the heat exchange fluid which circulates through the geothermal heat pump system. There are also hybrid systems that are utilized based on the geography of an area or other restrictive covenants which may be placed on a piece or region of real estate. Whichever geothermal heat pump system is used largely depends on the demands of the site, and there is not a massive price deviation for any of them. With that being said, not all sites have suitable conditions for underground geothermal heat pump systems.

Costs

Geothermal heat pumps can be pricey upfront but will bring long-term cost savings. The installation of a geothermal heat pump for a 2,000-square-foot home will cost between \$15,000 and \$38,000.⁴⁴ This means the price per square foot for installation will come out to \$13.25. The payback period for a geothermal heat pump falls anywhere between 18-25 years. While there are cost savings in the long term, these pumps may require specialized maintenance servicing, which can be costly. Maintenance, however, is rarely required.

Tenants

When it comes down to it, tenants will be willing to pay higher rents if they know that their utility bills will be cheaper. Providing cheaper utilities justifies an increase in rent.

Additionally, more buyers are wanting green homes - geothermal heat pumps provide the most sustainable option for heating, since they are much more efficient than traditional air conditioning units.⁴⁵ Depending on the tenant and the community a property is placed in, having geothermal heating may work to attract and retain residents based not only on the fact that it is a green solution, but also because of cost savings from utility payments.

GEOHERMAL HEAT PUMPS (HVAC)

Investors

As mandates surrounding sustainable energy increase in prevalence, investors will view geothermal heating pumps as a means of future-proofing, in addition to the prospective home value which will be created by the installation of these systems.⁴⁶

Geothermal heat pumps truly are a long-term investment, and it comes down fundamentally to the preferences of the investor on whether they are willing to spend the upfront investment for a longer payback period.

Fig. 15- Chart that outlines potential NGBS points awarded for geothermal heat pump installation.

| Practice Number | Feature | Maximum Points ² |
|-----------------|---|---|
| 703.3.1 | Combination Space Heating and Water Heating System (Combo System) | 4 pts |
| 705.5 | Certified HVAC Contractor | 2 pts |
| 705.5.2 | Performance Verification | 3 pts |
| 705.5.3 | HVAC Verified by 3rd Party | 8 pts |
| 705.5.3 | HVAC Installation Conforms to Plans | 3 pts |
| 705.6.6.2 | HVAC Airflow Testing | 5 pts |
| 705.6.6.2 | Airflow Meets ACCA Requirements | 3 pts |
| 602.2 | HVAC Duct Leakage Testing | 3 pts (Self Test) 5 pts (3rd Party Test) |

FINAL RECOMMENDATIONS

Based on the six explored in this white paper, there are three key features identified that will provide the most value to Trademark and are recommended for implementation.

EV Charging

The implementation of electric vehicle charging has incredible potential when it comes to future proofing for the inevitable rise and dominance of the electric vehicle industry. The installation of chargers provides a way to capture and retain tenants who both have electric vehicles and are planning on purchasing one. In addition to boosting multifamily property values with electric vehicle charging capabilities, there is also the potential for a secondary stream of income through public and private charging. Beyond this, there are also many points available relating to electric vehicle charging stations for NGBS certification.

Mass Timber

Another recommended feature is mass timber. As a building material, it is strong, durable, and requires less build time in comparison to concrete. Because it is made out of wood, it produces less CO2 emissions than other materials as well. Though the material is slightly more expensive than concrete, the decreased build times and finishing costs make mass timber a cost-competitive option. Mass timber offers aesthetics, functionality, and health benefits to tenants and creates opportunities to claim points on the NGBS certification.

Green Concrete

Green concrete is a strong solution due to it providing sustainable and environmental benefits, while not resulting in additional financial costs. Green concrete helps Trademark reach NGBS certification as well. The one point to account for with green concrete is that there is low supply for this material, so a materials provider and contract must be established in advance prior to the beginning of a development.

References

1. Albers J, Bitner D. Green Is Good: Sustainability's Impact on Multifamily Performance. Cushman & Wakefield; 2022. Accessed November 21, 2022. [Cushmanwakefield.com](https://www.cushmanwakefield.com)
2. Antia S, Hyat T, Wilhelmus J. The New Dynamics of Private Markets. PGIM; 2022.
3. A Policymaker's Guide: The National Green Building Standard & LEED Comparison. NAHB; 2022. Accessed November 23, 2022. [NAHB.org](https://www.nahb.org)
4. LEED Certification | U.S. Green Building Council. www.usgbc.org. Published 2022. <https://www.usgbc.org/tools/leed-certification>
5. Marina D, Gibson M, Hunt M, McGinley R, Cahir S. The Role of ESG in the Multifamily Property Market. CBRE; 2021. Accessed November 21, 2022. [Cbre.ie](https://www.cbre.ie)
6. NCBS Green Certification | Home Innovation Research Labs. www.homeinnovation.com. Published 2022. Accessed November 22, 2022. https://www.homeinnovation.com/services/certification/green_homes/resources
7. Saad L. Where U.S. Investors Stand on ESG Investing. Gallup.com. Published February 23, 2022. Accessed May 14, 2022. <https://news.gallup.com/poll/389780/investors-stand-esg-investing.aspx>
8. Serville C. How to Choose a Green Certification Program. Multifamilyexecutive.com. Published May 29, 2013. Accessed November 21, 2022. https://www.multifamilyexecutive.com/design-development/green/how-to-choose-a-green-certification-program_o
9. Strathon C, Lester E, Simo H, Chadwick E. Return on Sustainability. JLL; 2022.
10. Yang H. LEED: Greenwashing or Good for the Planet? Novel Hand | Activism, Meet Impact. Published March 9, 2021. Accessed November 22, 2022. <https://novelhand.com/leed/>
11. State of IOT 2022: Number of connected IOT devices growing 18% to 14.4 billion globally. IoT Analytics. <https://iot-analytics.com/number-connected-iot-devices/>. Published June 14, 2022. Accessed November 24, 2022.
12. What is the internet of things (IoT)? What Is the Internet of Things (IoT)? [https://www.oracle.com/internet-of-things/what-is-iot/#:~:text=The%20Internet%20of%20Things%20\(IoT\)%20describes%20the%20network%20of%20physical,andsystems%20over%20the%20internet](https://www.oracle.com/internet-of-things/what-is-iot/#:~:text=The%20Internet%20of%20Things%20(IoT)%20describes%20the%20network%20of%20physical,andsystems%20over%20the%20internet). Accessed November 24, 2022.
13. PointCentral. How IOT can transform rental property management. PointCentral. <https://www.pointcentral.com/2022/04/07/how-iot-can-transform-rental-property-management/#:~:text=PointCentral's%20Property%20Management%20Insights%20Report,per%20month%20for%20smart%20apartments>. Published May 10, 2022. Accessed November 24, 2022.
14. Schlage. Results of Schlage's Industry Insight Survey reveals what Millennial Renters Want in 2017. Results of Schlage's Industry Insight Survey Reveals What Millennial Renters Want in 2017. <https://www.prnewswire.com/news-releases/results-of-schlages-industry-insight-survey-reveals-what-millennial-renters-want-in-2017-300369197.html>. Published June 29, 2018. Accessed November 24, 2022.
15. HomeAdvisor. Learn how much it costs to install a home automation system - compose: Seo. 2022 Smart Home Costs: How Much Does Home Automation Cost? <https://www.homeadvisor.com/cost/electrical/install-or-repair-a-home-automation-system/>. Published October 11, 2022. Accessed November 24, 2022.
16. Energy savings from Nest White Paper Preview - storage.googleapis.com. Energy savings from Nest White Paper Preview. <https://storage.googleapis.com/nest-public-downloads/press/documents/efficiency-simulation-white-paper.pdf>. Published May 2014. Accessed November 24, 2022.
17. Energy Efficiency Program sponsor frequently asked questions about energy star smart thermostats. ENERGY STAR. https://www.energystar.gov/products/heating_cooling/smart_thermostats/smart_thermostat_faq. Accessed November 24, 2022.
18. Louis, Jean-Nicolas & Caló, Antonio & Pongrácz, Eva. Smart Houses for Energy Efficiency and Carbon Dioxide Emission Reduction. April 2020.
19. Cover, Jennifer. Mass Timber: The New Sustainable Choice for Tall Buildings. International Journal of High-Rise Buildings, vol. 9, no. 1, 한국초고층도시건축학회, Mar. 2020, pp. 87-93, doi:10.21022/IJHRB.2020.9.1.87.
20. Allen D. Urban building with Mass Timber. Urban building with mass timber. <https://www.metsagroup.com/metsawood/news-and-publications/articles/building-extensions-by-daniel-allen/>. Published July 24, 2017. Accessed November 24, 2022.
21. Busta H. Mass timber 101: Understanding the emerging building type. Construction Dive. <https://www.constructiondive.com/news/mass-timber-101-understanding-the-emerging-building-type/443476/>. Published May 24, 2017. Accessed November 24, 2022.
22. Bergeron P. Mass timber a key material for ESG-driven tenants. GlobeBest. <https://www.globest.com/2022/04/25/mass-timber-a-key-material-for-esg-driven-tenants/>. Published April 25, 2022. Accessed November 24, 2022.
23. Putting nature to work: Biophilic design a boon for corporate culture. Think Wood. <https://www.thinkwood.com/blog/biophilic-design-a-boon-for-corporate-culture#:~:text=Blog,Putting%20Nature%20to%20Work%3A%20Biophilic%20Design%20a%20Boon%20for%20Corporate,productivity%20and%20sense%20of%20wellness>. Published September 27, 2022. Accessed November 24, 2022.
24. Felmer G, Morales-Vera R, Astroza R, González I, Puettmann M, Wishnie M. A Lifecycle Assessment of a Low-Energy Mass-Timber Building and Mainstream Concrete Alternative in Central Chile. Sustainability. 2022 Feb 1;14(3):1249. doi: 10.3390/su14031249
25. Eco-friendly alternatives to traditional concrete. Specify Concrete. <https://www.specifyconcrete.org/blog/eco-friendly-alternatives-to-traditional-concrete#:~:text=Green%20concrete%20is%20a%20form,considered%20cheap%20and%20more%20durable>. Accessed November 28, 2022.
26. Fattah KP, Al-Tamimi AK, Hamweyah W, Iqbal F. Evaluation of sustainable concrete produced with desalinated reject brine. International Journal of Sustainable Built Environment. 2017;6(1):183-190. doi:10.1016/j.ijsbe.2017.02.004
27. Alqahtani FK, Abotaleb IS, Elmenshawy M. Life cycle cost assessment of green lightweight concrete utilizing recycled plastic based lightweight aggregates. Construction Research Congress 2022. 2022. doi:10.1061/9780784483978.057
28. Habert G. Environmental impact of Portland Cement Production. Eco-Efficient Concrete. 2013:3-25. doi:10.1533/9780857098993.13
29. American Concrete Institute. <https://www.concrete.org/publications/internationalconcreteabstractsportal/m/details/id/51663847>. Accessed November 28, 2022.
30. Scoring tools for NCBS Green Certification. ICC 700 National Green Building Standard (NCBS) Scoring Tools | Home Innovation Research Labs. <https://www.homeinnovation.com/greenscoring>. Accessed November 28, 2022.
31. Green roofs. GSA. <https://www.gsa.gov/governmentwide-initiatives/federal-highperformance-green-buildings/resource-library/integrative-strategies/green-roofs>. Published June 4, 2021. Accessed November 28, 2022.
32. Sempergreen. <https://www.sempergreen.com/en/solutions/green-roofs/green-roof-benefits>. Accessed November 28, 2022.
33. Green roofs. GSA. <https://www.gsa.gov/governmentwide-initiatives/federal-highperformance-green-buildings/resource-library/integrative-strategies/green-roofs>. Published June 4, 2021. Accessed November 28, 2022.
34. Green roofs. GSA. <https://www.gsa.gov/governmentwide-initiatives/federal-highperformance-green-buildings/resource-library/integrative-strategies/green-roofs>. Published June 4, 2021. Accessed November 28, 2022.
35. Feng H, Hewage KN. Economic benefits and costs of green roofs. Nature Based Strategies for Urban and Building Sustainability. 2018:307-318. doi:10.1016/b978-0-12-812150-4.00028-8
36. Bianchini F, Hewage K. Probabilistic Social Cost-benefit analysis for green roofs: A lifecycle approach. Building and Environment. 2012;58:152-162. doi:10.1016/j.buildenv.2012.07.005
37. Electric vehicles - US: Statista market forecast. Statista. (n.d.). Retrieved November 21, 2022, from <https://www.statista.com/outlook/mmo/electric-vehicles/united-states#:~:text=The%20Electric%20Vehicles%20market%20in,US%24139.10bn%20in%202027>
38. Electric vehicles - US: Statista market forecast. Statista. (n.d.). Retrieved November 21, 2022, from <https://www.statista.com/outlook/mmo/electric-vehicles/united-states#:~:text=The%20Electric%20Vehicles%20market%20in,US%24139.10bn%20in%202027>
39. Q.ai - Powering a Personal Wealth Movement. (2022, October 12). Growth sector: Electric vehicles sales and the new electric economy have arrived. Forbes. Retrieved November 21, 2022, from <https://www.forbes.com/sites/qai/2022/09/24/growth-sector-electric-vehicles-sales-and-the-new-electric-economy/?sh=17413200143a>
40. Plug-in electric vehicle charging plug-in electric vehicle ... - veloz. (n.d.). Retrieved November 22, 2022, from https://www.veloz.org/wp-content/uploads/2017/08/MUD_Guidelines4web.pdf
41. Villarreal, B. (2022, August 16). Attracting and retaining tenants with EV charging. SemaConnect. Retrieved November 22, 2022, from <https://www.semaconnect.com/resources/blog/attracting-and-retaining-tenants-with-ev-charging/>
42. Geothermal heat pumps. Energy.gov. (n.d.). Retrieved November 23, 2022, from <https://www.energy.gov/energysaver/geothermal-heat-pumps>
43. Dandelion Energy. (2020, March 10). Geothermal Environmental Benefits. Dandelion Energy. Retrieved November 23, 2022, from <https://dandelionenergy.com/environmental-benefits-of-geothermal-heat-pumps#:~:text=Geothermal%20Lowers%20Carbon%20Emissions,17%2C000%20pounds%20of%20carbon%20dioxide>
44. Geothermal heat pumps: Installation and repair costs 2022. Modernize. (n.d.). Retrieved November 23, 2022, from <https://modernize.com/hvac/heating-repair-installation/heat-pump/geothermal>
45. Tobias, M. (2022, November 23). 20 green design features for buildings. MEP Engineering & Design Consulting Firm. Retrieved November 23, 2022, from <https://www.ny-engineers.com/blog/20-green-design-features-for-buildings>
46. Home. The Robert Little Group. (n.d.). Retrieved November 23, 2022, from <https://www.totalvegasrealestate.com/can-geothermal-increase-home-value/>

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