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LEEDing Power Back to Communities through Green Building Codes - Advice for Policymakers Considering LEED Certification

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Executive Summary

In this paper, I compare goals of original, local green building codes and their potential for projects to use LEED certification as a path of compliance. Examples include the City of Golden's Sustainability Menu, the newly adopted Denver Green Code, the City of Lakewood's Enhanced Development Menu, and the Federal Guiding Principles. By using my professional experience in LEED certification to analyze these codes' language and priorities, I provide guidance on the applicability of LEED to achieve energy efficiency and renewable energy goals set by jurisdictions. I also interviewed two professionals in the field, a sustainability consultant with experience in local green building codes, and an energy engineer who analyzes building energy performance using energy modeling.

My studies show that the public perceptions of LEED differ from both the intentions of the rating system and its real-world impacts according to academic literature. I suggest to policymakers not to rely on the widespread acceptance of LEED to communicate a sustainability commitment, but instead use locally specific codes that require needed changes in their communities. If LEED must be utilized, codes should be credit-specific and avoid broad requirements like 'LEED Gold-Certified.' When requirements are broad, control is taken away from local governments, and their goals may not be met. While LEED is an excellent tool to holistically increase a building's sustainability, I caution that LEED does not progress the energy transition as much as people believe.

List of Abbreviations

LEED	Leadership in Energy and Environmental Design
USGBC	U.S. Green Building Council
GBC	Green Building Codes
RE	Renewable Energy
CSAB	Climate Sustainability Advisory Board
CASR	Climate Action, Sustainability, and Resiliency
GBO	Green Building Ordinance
DGC	Denver Green Code
EDM	Enhanced Development Menu
FGP	Federal Guiding Principles

Table 1: Summarizing Table of Local Green Building Codes and LEED

Code/System	Qualifying Metric	Compliance Metric	Energy-Biased?	LEED as a Path for Compliance?
Golden Sustainability Menu	All new commercial and multifamily projects	Mix of self-prescribed requirements and choices.	Yes, but holistic sustainability available	Yes – Gold Level Required if chosen
Denver Green Code	All new building projects	Required and elective provisions	Holistic Sustainability	Yes -Platinum or Net Zero Energy
Denver Green Building Ordinance	Buildings ≥25,000 sf	Choose one of four options	Half of options relate to RE or energy efficiency.	Yes - Gold
Energize Denver Benchmarking	All existing buildings	Decreased Energy Use Intensity	Explicitly – energy performance reporting system	No
Lakewood Enhanced Development Menu	All building projects	Point-based, scaled to project size.	Holistic Sustainability	Yes – Gold Level can satisfy 100% of points.
Guiding Principles for Sustainable Federal Buildings	Federal major renovations, modernizations, and new constructions	Mix of requirements and options based on project type	Holistic Sustainability	Yes – Projects must still meet building-level requirements
LEED (for reference)	Any building project can pursue	Point-based, prereqs and credits	Energy credits make up bulk of points (Appendix A)	N/A

Introduction

The Leadership in Energy and Environmental Design (LEED) rating system has been pushing the built environment to reduce its world impact through attainable methods for the past three decades [1]. The organization behind LEED, the U.S. Green Building Council (USGBC), boasts massive impacts, causing LEED to be synonymous with the idea of 'green' and 'sustainable' buildings.

Buildings account for a massive share of current energy demand. In 2022, buildings demanded up to 48.4% of the energy consumption and contributed to 31.6% of the energy waste in the United States [2]. Buildings also offer some of the easiest options to contribute to the renewable/decarbonized energy transition by integrating renewable technologies and by becoming more efficient through improvements to systems, behaviors, and the design of the building itself. This is how certifications like LEED take part in the industry. By setting quantifiable goals for design teams and actors in the building industry to achieve, small improvements to energy and environmental performance can be made in bulk. These goals are called 'credits' and tackle a single aspect of 'energy and environmental leadership' which each have an associated number of points for thresholds of achievement. Points are totaled for the project, which is then awarded a level of certification: Certified, Silver, Gold, or Platinum [Appendix A].

Buildings pose both problems and solutions within the energy transition, and LEED may be the tool best suited to manifest these solutions. In an effort to become more sustainable, some cities are defining their own green building systems which require projects to participate in the city's overall goals. Using examples from the federal government as well as Golden, Denver, and Lakewood, Colorado, I compare the goals of these original, green building codes and their alignment with the LEED rating system. Many of these codes use LEED as a path to compliance, but LEED may be misaligned with the city's goals. To ensure that the cities see improvements that their community needs, I propose that policymakers should maintain control over their buildings' performance and assess whether LEED fits their communities' values.

Literature Review

To understand coverage of the topics of decarbonization, green building certifications, energy efficiency, the energy transition, and LEED in the context of academic research, a brief numerical literature review was conducted. Searching within the journals *Energy Policy* and *Energy Research & Social Science* from 2019 to 2023, the number of articles published on the selected topics are shown in Figure 1.

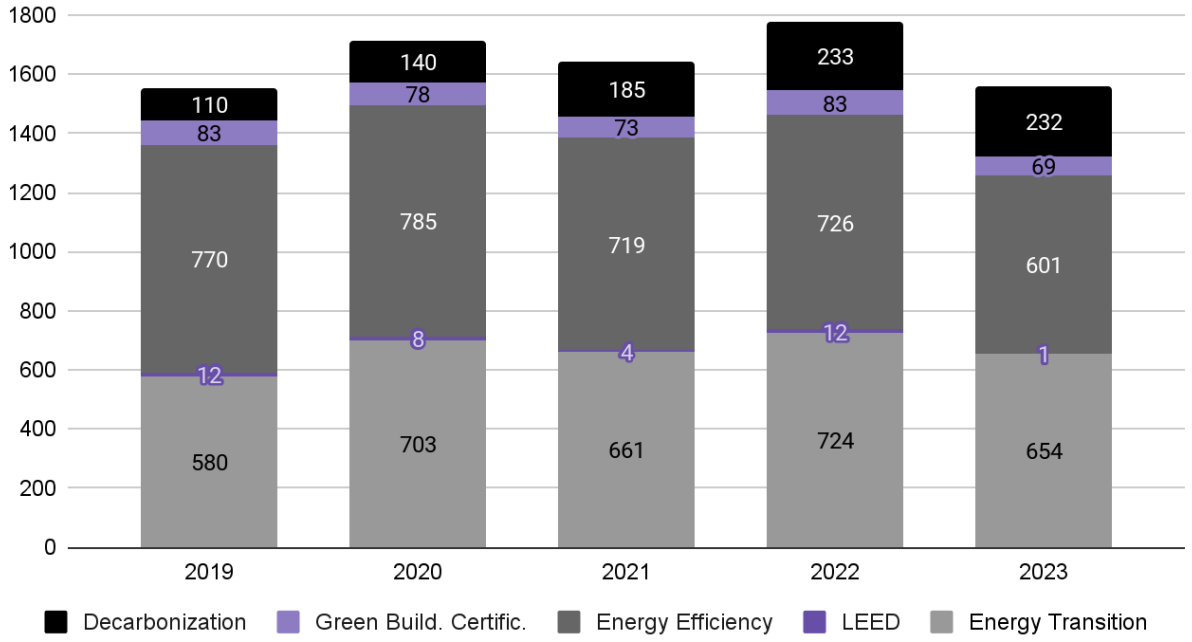

Figure 1: Numerical literature review (Energy Policy + Energy Research & Social Science)

This reveals a strong preference for the overarching topics of transition and efficiency in the social science spaces. The number of articles regarding LEED are sparse, and hardly register in Figure 1. While conducting this review, no recent articles investigated the relationship of public perception and actual impact of LEED, which is considered in this paper. Because of this, I performed a pilot study to understand public perception at the Colorado School of Mines and will use existing literature of the actual energy performance of LEED-certified buildings to compare the perceived versus actual impacts of LEED in the energy transition[1].

I also sought to understand the relationship between certification systems, the energy transition, and specific localities. In three cities in Utah: Salt Lake City, Park City, and Moab, Skill et al. report on how municipalities can participate in the energy transition. They identify a five-step framework: "1) using trigger events for inspiration; 2) envisioning change; 3) identifying challenges and potential solutions; 4) building support; 5) taking it to a vote." The authors do include buildings and local building codes as part of this effort, however, mostly to increase building energy efficiency [3]. Liu et al. make a more explicit connection to buildings by showing how major barriers to the implementation of green-labeled residential buildings lies more on social trust in the buildings rather than their technological and economic systems [4]. While third-party certification system have the opportunity to become expert governance institutions that could both inspire and enforce change, Sedlacek and Maier believe that it is too early to empirically prove that could be the case [5].

Other suggestions can be found for legislators who would like to see more specific impacts. If retrofits and the evaluation of existing buildings are important to localities, the article *Building green retrofit in China: Policies, barriers and recommendations* by Liu et al. provides guidance based on their experience on the topic in China [6]. Abbasi et al. also propose that energy retrofits/renovations may provide a unique opportunity to tangentially address fuel poverty (also referred to as energy

[1] This was part of a final project for a course in Energy & Society. The original document can be made available by request.

poverty [7]), the state where residential households spend over 10% of their income on operating HVAC systems [8], [9]. If a reduction in emissions are a goal for jurisdictions, Skillington et al. suggest that there should be additional requirements within voluntary instruments like LEED, maximum emission allowances, and mandatory whole building life cycle analysis reporting to enact this change [10].

Case Studies

City of Golden, Colorado - Sustainability Menu

Overarching Climate Plans

"Community Sustainability Advisory Board defines Sustainability as living or acting in a manner that balances improving our quality of life, a healthy vibrant community, and mindful stewardship of the natural resources and environment while protecting the ability of future generations to do the same." [11]

In 2020, the city of Golden, a small town located West of Denver, Colorado and placed between mountains and mesas, published their Sustainability Strategic Plan [11]. This was an update from the past five year plan published in 2015 [12] and extends into 2025. The Community Sustainability Advisory Board (CSAB), the subset of Golden's City Council, was originally established in 2007.

In general, the CSAB has goals related to energy, waste, and water [13]. When not looking at goals related directly to buildings, energy goals include the electrification of Golden's vehicle fleet, the implementation of city-owned renewables, and developing guidelines for the balance of trees and solar installations. Waste goals include increasing the rates of diversion for recycling and composting streams, overall reduction of waste, and the net-zero waste operations of municipal buildings. Lastly, for water, goals include increased resilience in times of drought and proper management of surplus water. [11]

Guidelines for Buildings

On top of requiring new city-owned buildings achieving LEED BD+C Silver [14], Golden's CSAB has also implemented a 'Sustainability Menu' for local buildings as a means to achieve the building-related goals in the Sustainability Strategic Plan. The Sustainability Menu is an original certification system that applies to all commercial and multifamily buildings which have at least three units. The Menu has undergone multiple iterations, and currently is split into three sections: Section I (all applicable standards must be met), Section II (half of applicable standards must be met), and the Menu (20 points must be achieved, with the threshold increasing when the building has extraneous energy use applications). [15]

In Section I, out of the 11 standards, six of them are energy related. If the building is occupied, it seems that all the standards will be applicable to a given project. In Section II, three of the ten standards are energy related, and all ten seem to be applicable by the same metrics as Section I. The Menu section is split into two subsections: Energy Efficiency and Community Preservation & Revitalization. As mentioned previously, only 20 points are required for this section. Three of the four Energy Efficiency items can achieve that 20-point requirement. None of the Community Preservation & Revitalization items can single handedly achieve compliance. This seems to indicate that CSAB would prefer for projects to do Energy Efficiency over Community Preservation & Revitalization. To avoid energy efficiency measures in the Menu section, a project would need to preserve the structure of a historic building, add 5,000 square feet, and offer five units that are priced affordably. Not to mention, the historic building preservation option includes a clause that

the building's energy efficiency is increased. In the case that a project team wants to do the least work, it would make sense for them to choose an option that is all-encompassing, which only leads to energy efficiency. [15]

Golden's Sustainability Menu does include the ability to utilize LEED Gold certification or Passive House (another certification system that aims to eliminate the need for energy systems [16]) to satisfy the Menu section. There is no specification of what credits within LEED Gold should be achieved. A discussion of whether LEED Gold is an appropriate replacement for explicit energy efficiency measures will be provided later in this paper.

City of Denver, Colorado - Denver Green Code & More

Overarching Climate Plans

The City and County of Denver has an office of Climate Action, Resilience, and Sustainability (CASR), which was founded in 2020 and has a mission of using "science-based strategies to reduce greenhouse gas emissions," "cultivate resiliency in the face of potential climate change-related emergencies," and "secure an economically, socially, and environmentally sustainable city for generations to come." [17] The Sustainability Action Board assists in developing more specific metrics to achieve these goals, which (like most climate action plans) includes focuses in workforce development, renewable energy, adaption & resiliency, environmental justice, sustainable transportation, high performance buildings & homes, and zero waste [18]. Denver also hosts a 'Certifiable Green Denver' program which allows businesses to participate in Denver's overall goals [19]. The city and county devotes $40M to CASR's efforts, and the goal of carbon neutrality is the year 2040, with an intermediate goal of 65% by 2030 based on 2019 data [20].

Guidelines for Buildings

Denver's relationship with its own regulation on buildings has undergone significant development over the past three years. Three initiatives are the primary means for Denver's goals as they pertain to buildings: Energize Denver Benchmarking, the Green Building Ordinance, and the Denver Green Code.

Established in 2022, Energize Denver is a benchmarking initiative that governs every existing building's (with the exception of single family homes) energy use intensity (EUI) which is typically measured in kBTU/sf-year (energy per square foot per year) [21]. The intent of the program is to require measurable increases in energy efficiency every year, and there are three distinct groups with different requirements: ≥25,000 sf, <25,000 & ≥5,000 sf, and <5,000 sf. The overarching goal is to diminish commercial and multifamily building's emissions by 80% by 2040. Energy demand reductions are achieved primarily by improvements in lighting and HVAC systems, but renewable energy (RE) does also play some role in benchmarking. [21]

The Green Buildings Ordinance (GBO) was adopted in 2018 [22] and may be seen as the precursor to the Denver Green Code (DGC), which was adopted in 2022 [23]. This is not entirely the case, as it is still used alongside the DGC. Applying to projects at least 25,000 gross square feet, the GBO was initially intended to reduce the heat islanding effect in Denver. Compliance can be achieved through the use or combination of green space, RE (on or off-site), green building certification, and the combination of electrification and energy efficiency. The DGC, however, gathers a more holistic approach to sustainability and includes requirements in areas like indoor air quality, embodied carbon, water use, and operations. The DGC is much closer to being its own certification system and can be achieved via LEED Platinum certification or Zero Net Energy. The DGC has a collection of required and elective provisions and is required for all projects.

City of Lakewood, Colorado - Enhanced Development Menu

Overarching Climate Plans

"The city will reduce its impact on natural systems, instill greater awareness of waste output and reduce waste, seek renewable energy sources, and provide for a sustainable community through education, programs, and services." [24]

Lakewood, Colorado is a suburban city located between Denver and Golden. According to their Lakewood Sustains document, a chapter of their Comprehensive Plan, the city has goals for each of the following sections: City Leadership & Role, Air Quality & Climate, Water, Biodiversity/Natural Resources/Ecosystem Services, Energy in Built Environments, and Waste. [24]

Guidelines for Buildings

Within the Energy in Built Environments section, Lakewood's overarching goals are to "increase resource efficiency in buildings" and to "increase energy provided from renewable energy sources." [24] In order to contribute to these energy goals and other built environment related sustainability efforts, the city of Lakewood has adopted the Enhanced Development Menu [25]. The latest revision was in 2022, and is applicable to most building projects, new and existing, above 2,500 square feet.

Lakewood has included a good synopsis behind the EDM and its intent in the following statements: "The Enhanced Development Menu (EDM) is a point-based system of sustainable development options ranging from renewable energy to public art. New developments must achieve a required number of points based on the project's square footage… The EDM is intended to ensure new development is a positive investment in the community, either by directly providing community amenities or by minimizing the impact on limited water and energy resources. It is designed to be flexible and context-specific, allowing for a wide variety of items to be implemented within a development site that holistically promote city goals." [25]

There are 28 distinct menu items that span across energy, water, materials, transportation, and human experience. The required number of points is based on square footage, with 1 point/1,000 sf with a minimum of 10 and maximum of 150 points. Green building certification is a path to compliance and can satisfy 75-100% of a project's required points. This percentage is based on the level of certification, where LEED Gold qualifies for 100% points and LEED Silver is 75%. NGBS, a different rating system, is also swappable for LEED at the same levels of certification. Green building certification is also the first of the 28 available items listed and is the only item that could alone satisfy the entire EDM for projects of ≥150,000 sf. Otherwise, projects have a prerequisite of 20 points in environmental impact reductions and improved social aspects or a fee-in-lieu for any of the 40 points not achieved. [25]

Federal Buildings - United States

Overarching Climate Plans

The United States federal government has published goals through the Office of the Federal Chief Sustainability Officer [26]. Because of their status as a country-scale government, their overarching driver is to limit global warming by 1.5 degrees. The office has defined nine metrics that can help achieve that goal: [26]

1. 100% Carbon Pollution-Free Electricity by 2030, including 50% on a 24/7 basis.
2. 100% Zero-Emission Vehicle Acquisitions by 2035, including 100% light-duty acquisitions by 2027.

3. Net-Zero Emissions Buildings by 2045, including a 50% reduction by 2032.
4. Net-Zero Emissions Procurement by 2050.
5. Net-Zero Emissions Operations by 2050, including a 65% reduction by 2030.
6. Climate Resilient Infrastructure and Operations.
7. Develop a Climate- and Sustainability-Focused Workforce.
8. Advance Environmental Justice and Equity-Focused Operations.
9. Accelerate Progress through Domestic and International Partnerships.

Guidelines for Buildings

In alignment with goals three and six, the government has defined the Guiding Principles for Sustainable Federal Buildings (often referred to as the Federal Guiding Principles, or FGP). The FGPs are broken down into six principles: [27]

1. Employ Integrated Design Principles
2. Optimize Energy Performance
3. Protect and Conserve Water
4. Enhance the Indoor Environment
5. Reduce the Environmental Impact of Materials
6. Assess and Consider Building Resilience

These principles are applicable to all existing federal buildings, new constructions, or major renovations. Each has subgoals, and by name alone, many are similar to LEED credits. The subgoals have different specifications and requirements dependent on whether the project is an existing building, a new construction or modernization, or a major renovation. [27]

LEED is a path for compliance for both new and existing buildings, but there remains a caveat:

"The Guiding Principles and associated criteria include references to statutory and regulatory requirements, many of which are not specifically referenced in third-party certification systems. If an agency chooses to utilize a third-party system for the purposes of qualifying and reporting a building as a sustainable Federal building, it must also ensure that all building-level statutory and regulatory requirements are met. GSA has developed resources to assist agencies in identifying specific credits within each third-party system that may align with meeting various statutory and regulatory requirements, as referenced in the Guidance. These GSA resources are provided for informational purposes; agencies remain responsible for ensuring that meeting the credits indicated also meet the relevant statutory and regulatory requirements. These additional resources can be found on GSA's SFTool: Guiding Principles for Sustainable Federal Buildings." [27]

Discussion

Green Building Certifications and Holistic Sustainability

Based on my experiences and the feedback gathered from professionals in the field, green building certifications can be an excellent method to increase awareness and public buy-in to sustainability overall. LEED outlines this well with their eight credit categories: Location & Transportation, Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, Indoor Air Quality, Innovation, and Regional Priority [28]. Each of these tackles a specific subsect of sustainability. The first six are well defined and understood, and the last two account for the complexity of the sustainability industry. Innovation is meant to provide projects with the ability to apply 'Pilot Credits' to their assessment. Pilot Credits are efforts that LEED is considering adding to

the larger list, or aspects of a building that are not widely applicable but are proven to benefit occupants, the environment, or society. The Regional Priority category recognizes that LEED is not inherently local, and it allows different subgroups of USGBC to define credits that are especially beneficial to their region and reward projects for participating in those credits.

If the public is aware of this broad scope, then LEED is successful in growing the public's awareness of the large role that building projects have in issues of sustainability. In a pilot study conducted by myself in the late 2023, I found that on the Mines campus, people were largely aware that LEED was concerned with efforts in energy and water, and there was also a moderate understanding of wider sustainability topics. Most importantly, my preliminary findings revealed that nearly half of participants in my survey believed that aspects like net-zero carbon emissions and RE production were required by LEED. However, only a small percentage of respondents believed that preservation of trees, net-zero water use, or a social justice measures like gender-neutral bathrooms were required for certification. While this was only a brief study of a non-representative population of Mines (and much less so of the American population), if these findings are *at all* representative, we would see a misconception within the population that believes we are farther into the transition than we are. If policymakers also share this perspective, we might see LEED become a widespread tool that intends to make a greater impact on the transition than possible.

Green Building Certifications and Energy Modeling

We cannot discuss buildings' role in the energy transition without addressing how energy models are integral to this process. I have myself developed energy models through a class in my undergraduate studies but have no professional experience in the trade. Through my experience in LEED, I have observed that the results of energy models heavily influence the level of certification that a building can be awarded. The credit 'Optimize Energy Performance', rewards up to 9 points for energy efficiency improvements of 50% shown by pre-construction energy models [29]. This is in addition to the prerequisite 'Minimum Energy Performance,' where projects must, "comply with ANSI/ASHRAE/IESNA Standard 90.1–2010." [30]

To contextualize the role of energy models, I spoke with a colleague who works as energy project manager and spends their time creating, adjusting, and analyzing energy models for projects under local GBCs and various certification systems. When interviewing them, I especially wanted to understand the current criticisms of energy models, how those critiques are being addressed, and how LEED and building codes utilize energy models. The largest takeaway from our conversation was that local energy codes (which are in addition to GBCs) are, as it currently stands, more stringent than LEED. The requirements that LEED uses are based in the standards of the early 2010's, and the rest of the industry has progressed far enough that these standards are no longer aggressive.

The documentation required to prove energy efficiency upgrades require modelers to use comparative modeling where they develop a baseline building according to the ANSI/ASHRAE/IESNA Standard 90.1–2010 [30], which defines attributes of the building that equalizes the playing field for each project. Modelers then show adjustments to their model that reduce the building's EUI. The modeler, architects, engineers, and sustainability consultants then decide what is the most cost-effective path to earn compliance to the certification or code that is of concern to the team. From there, it is on the architects and engineers to reflect these changes into their drawings and specifications that will be implemented into the constructed building. The level of efficiency, according to my colleagues in energy modeling and sustainability consulting, is often

governed by the level of certification pursued, where buildings seeking LEED certification at the Gold level will often be more efficient than those at the Silver level.

LEED and its Impacts

The impact of LEED's stamp of approval on buildings' energy savings has been contested for many years. In 2009, Newsham et. al. did a study on the correlation between certification level (Certified, Silver, Gold, or Platinum), number of energy credits earned, and the associated building's energy performance [31]. Using a dataset of 100 newly constructed LEED-certified buildings, they were not able to detect trends between the aforementioned aspects of the buildings. Overall, they also found that, "on average, LEED buildings used 18–39% less energy per floor area than their conventional counterparts. However, 28–35% of LEED buildings used more energy than their conventional counterparts." [31] This implies that the public may be able to have a false sense of energy performance that is a function of increasing certification levels, and it is not safe to assume every LEED building has better energy performance than typical buildings. 2009 was a very different time for LEED; the third version was published that year (dubbed v2009), version 4 in 2015, and just recently version 5 has emerged in beta starting in September of 2023 [32].

While we are still amid the same energy transition as we were in 2009, the way that LEED handles energy has had 14 years to adapt since this study. Clay et. al. performed a study in 2023 comparing certified and not certified retrofitted federal buildings [33]. Their findings are similar, but the scope is limited to the nature of federal buildings in their dataset, which spans from 1990 to 2019. The team states in their paper, "despite energy savings being an explicit federal goal, LEED-certified retrofits of federal buildings did not have statistically significant energy savings on average." However, at the same time, "LEED buildings with higher energy scores had greater energy efficiency post-certification, and the improvements were economically meaningful." This means that trade-offs occur elsewhere in the building that led to total energy consumption not changing, or that all federal buildings had become less energy intensive [33]. While these two studies have different datasets, they show that LEED has continued their history of having actual impacts on building energy performance that differ from what design teams intend, or in the case of my study, what the public thinks is happening behind the plaque.

Even if the buildings are performing to the extent assumed by the public in terms of energy efficiency, there still remains a gap on the building's impact on the environment due to said energy performance improvements [34]. Because of the scale of the United States, grid energy emissions can vary greatly from locality to locality. This means that the same amount of energy saved in a coal-dominant grid would be more impactful to mitigating climate change than one in a wind-dominated grid. The study by Greer et. al. shows that this is only part of a miscommunication that exists between LEED's scope of the energy transition and the actual effects on society. By rewarding different cases the same number of points (like the two compared previously), LEED communicates that specific building performance is the end goal of designing better buildings. Greer et. al. argues that this conflicts with LEED's explicit goals (which are embodied in their seven 'Impact Categories'), and that "energy efficiency credits are not clearly linked to any of the Impact Categories." [34] To many, this may look like an explicit use of greenwashing, where USGBC's written goals are not in alignment with their actions. This might be valid, but it is important to recognize the United States is a unique energy landscape in its variety, and that local versions of LEED could be the only way to combat this problem. The necessary level of specificity could potentially go all the way down to the city level. This may raise its own problems, where the variety of LEED could water down the entire system's perception.

All of these findings, however, are based in historical data, and do not necessarily represent the future reality of LEED certified buildings. An update to the credit was made in early 2024, which consultants in industry expect will halve the number of achievable points. The v4.1 change replaces the baseline from ASHRAE Standard 90.1–2010, to ASHRAE Standard 90.1–2016 and aims to adjust the credit so that it is once more pushing advancements in the industry beyond what is required by code. Any project registered[2] after the time of publishing this paper will be affected by this change. We have yet to see the outcomes of this change, but the likely cases will be that the buildings registered after this change will 1) score lower on the system, 2) become more efficient at the same level of certification, 3) seek out points in other credits to preserve the same level of certification, 4) abandon LEED for other certification systems[3] or, 5) pursue no certification. At face value, the first three outcomes seem beneficial, but ongoing research needs to be conducted to evaluate the actual impacts of updated standards. We should also analyze if the public's perception changes with these industry transitions.

Advice for Policymakers

If Energy Efficiency is a Priority

For jurisdictions seeking to lower their overall energy use, I warn that allowing for LEED (even at the Gold level) to be a path of compliance does not actually demand a specific level of energy efficiency. While LEED is publicly seen as inherently energy efficient, the literature suggests otherwise, and it currently is less strenuous than many energy codes. I expect that design teams will often opt for this path due to the certification system's public recognition, and this path shifts the power away from jurisdiction and into the hands of design teams and the flexibility of LEED. Golden's Sustainability Menu is a prime example of this. Their menu is clearly swayed towards impacts on energy, but the complicated self-prescribing system may push design teams to seek a more well-known and straightforward path. This path is not necessarily more energy efficient and may not satisfy Golden's overall goals.

To achieve energy demand reductions, adapting your jurisdiction's energy code to match updated IECC codes and having locality-specific interventions (like the use of ERVs in humid climates vs. HRVs in dry climates [36]) should better guarantee the impacts intended by legislators. Lowering the barriers to implementation should also improve performance. A team that has not had to wrestle with the language of your code should be more willing to comply. Vague language and increased work on the team might increase the rate of malicious compliance. Codes should be written to communicate the importance of the changes, provide clear steps for teams to be taking, adequately reward more challenging and impactful changes, and provide third-party resources for designers who have little experience in green building design. Lakewood's EDM is a good example of well written requirements and transparent intentions.

Another consideration that your city should have is the use of commissioning to ensure that impacts will occur. LEED does include an 'Enhanced Commissioning' credit that has a third party inspect the quality of construction, which theoretically assess the implementation of the changes demanded

[2] This is distinctly different than a project being started or built. As long as a project has an address, it can be registered to LEED Online at any time, and the time of registration defines the applicable version of LEED. There are deadlines, but for LEED v2009, projects were able to be submit documentation until June 2022 [35].
[3] Under the Lakewood EDM, projects might go for NGBS instead of LEED to comply.

by the energy modeler. Ongoing commissioning (like Energize Denver) also might be a good idea for continuous improvements, especially in buildings with large demands.

If your locality absolutely wants to utilize the tools and visibility of LEED, I suggest that your codes do not simply require a level of certification. Requirements should be at the credit level (ex. 13 points from Optimize Energy Performance) and be equivalent to any original language written by legislators. This would look very similar to the caveat that was included in the Federal Guiding Principles, and localities should pursue the development of tools similar to the GSA's SFTool [27]. This may be a happy medium for both jurisdictions and designers, as there are ample resources for achieving LEED certification, and the local government does not have to do their own assessment. More research should be performed to explore the success of this approach.

If Renewable Energy Production is a Priority

My suggestions for the use of LEED as a way to increase energy efficiency are very similar when it comes to RE production. However, the existing point distribution of LEED exaggerates this issue. If project teams will be seeking local GBC compliance (likely LEED Gold), inspiration to devote the work, infrastructure, and costs of RE will be slim. Under v4, three points are available when the project owns a system that makes up 10% of the building's annual energy costs [37]. Under the updated v4.1, five points are available for a 20% offset using on-site RE generation [38]. LEED v4.1 also has options for off-site renewables and RE credit purchasing. By the nature of LEED, localities have little to no control for the achievement of these credits, so credit-specific requirements should be made by localities looking for increases in decentralized RE production through the LEED rating system.

The politics and infrastructure needed to add renewables to grids can be daunting, so I suggest that each local government should assess if building projects should have their own on-site production or whether they should partially fund the development of government-owned utility-scale renewables. A centralized utility-scale system may be easier to operate and expand, but the pairing of renewables and battery storage on-site may increase the resiliency of individual buildings. Engage with local RE professionals to ensure that your code is most appropriate for your specific context.

For continued harmony with the rest of the energy transition, localities may want to size RE systems according to *operational carbon* rather than *energy demand* or *energy costs*. By using grid-specific databases in grid intensities (like NREL's Cambium, EIA-930, or WattTime), the implementation of RE can account for the renewables already in the grid. This approach also better roots the problems of energy and makes the design team consider the broader impacts of their building's energy demand.

The Rise of LEED Version 5

At the time of publication, the public comment version of LEED v5 has become available to everyone [39], and major changes are included for LEED BD+C (Building Design and Construction, the most relevant application of LEED for this paper). Many of my critiques of LEED have been partially accounted for:

- The point distribution of Energy Efficiency and Renewable Energy remains the same, however, LEED v5 rewards 5 points to 100% RE versus v4.1's 20%.
- There are additional requirements for a building to achieve Platinum-level certification. This addresses some of the misconceptions I have observed about the inherent difference between different levels of certification. LEED Platinum buildings must perform at the highest level of electrification, energy efficiency, and RE production. Additional

requirements should be added for Gold-level certification if it will remain the industry's 'advanced' standard.

- LEED v5 is split up by focus areas: Decarbonization, Quality of Life, and Ecological Conservation & Restoration. These are then explicitly called out in each credit. This should also be used in local GBCs. This assists teams in understanding their broader impacts and allows them to either diversify their building or lean into one category more easily.
- It is unclear if the "Certified" level of certification has been eliminated, and it should in order to clarify our ability to communicate about a building's devotion to becoming greener. Writing an essay about LEED becomes difficult when you must clarify the difference between 'LEED Certified' and 'LEED Certified-Level Certification.'

As mentioned earlier, LEED v5 is open to public comment. Any and all people SHOULD submit their thoughts. The publication of this paper intends to lower the barriers to understanding the state of LEED, and I hope that it can help the public understand how this certification system can shape the built environment around us. Please reach out to me at nathanaelli@mines.edu for any questions about this paper, the LEED certification system, or for any concepts introduced in the paper that you would like to implement in your community.

Submit your LEED v5 Public Comments here!!!

Positionality Disclosure

I approach this study as an engineering student who has spent most of their time in the green building space. I recently have been shifting my work to include formal qualitative social studies to understand the impact of buildings on occupants, especially when considering their needs and how buildings can serve people in ways that the traditional design process does not account for. While doing this, I have also spent my professional time working at a consulting firm as an intern who specializes in LEED documentation.

LEED has been a specifically interesting measurement tool to me as someone who has experiences on both sides of the plaque, conversing with the public on what LEED means while doing the work to prove how buildings are sustainable through the lens of LEED. I also approach this as a building designer, and I look to investigate how the general public's perception of LEED may over influence the use of LEED as a standard to create meaningful changes in a community's energy use and production.

This paper was partially written and edited in a LEED Gold building.

Citations

[1] "LEED rating system | U.S. Green Building Council." Accessed: Nov. 09, 2023. [Online]. Available: https://www.usgbc.org/leed

[2] "Energy Flow Charts | Flowcharts." Accessed: Nov. 09, 2023. [Online]. Available: https://flowcharts.llnl.gov/commodities/energy

[3] E. E. Skill, S. Klain, and R. Brain McCann, "Running on renewables: Building local support for 100% net-renewable electricity resolutions at the municipal scale in the United States," *Energy Res. Soc. Sci.*, vol. 75, p. 101995, May 2021, doi: 10.1016/j.erss.2021.101995.

[4] Y. Liu, Z. Hong, J. Zhu, J. Yan, J. Qi, and P. Liu, "Promoting green residential buildings: Residents' environmental attitude, subjective knowledge, and social trust matter," *Energy Policy*, vol. 112, pp. 152–161, Jan. 2018, doi: 10.1016/j.enpol.2017.10.020.

[5] S. Sedlacek and G. Maier, "Can green building councils serve as third party governance institutions? An economic and institutional analysis," *Energy Policy*, vol. 49, pp. 479–487, Oct. 2012, doi: 10.1016/j.enpol.2012.06.049.

[6] G. Liu, X. Li, Y. Tan, and G. Zhang, "Building green retrofit in China: Policies, barriers and recommendations," *Energy Policy*, vol. 139, p. 111356, Apr. 2020, doi: 10.1016/j.enpol.2020.111356.

[7] K. Li, B. Lloyd, X.-J. Liang, and Y.-M. Wei, "Energy poor or fuel poor: What are the differences?," *Energy Policy*, vol. 68, pp. 476–481, May 2014, doi: 10.1016/j.enpol.2013.11.012.

[8] M. H. Abbasi, B. Abdullah, R. Castaño-Rosa, M. W. Ahmad, A. Rostami, and J. Cullen, "Planning energy interventions in buildings and tackling fuel poverty: Can two birds be fed with one scone?," *Energy Res. Soc. Sci.*, vol. 93, p. 102841, Nov. 2022, doi: 10.1016/j.erss.2022.102841.

[9] "What is fuel poverty?," National Energy Action (NEA). Accessed: Apr. 10, 2024. [Online]. Available: https://www.nea.org.uk/what-is-fuel-poverty/

[10] K. Skillington, R. H. Crawford, G. Warren-Myers, and K. Davidson, "A review of existing policy for reducing embodied energy and greenhouse gas emissions of buildings," *Energy Policy*, vol. 168, p. 112920, Sep. 2022, doi: 10.1016/j.enpol.2022.112920.

[11] T. Worsham, "2020 City of Golden Sustainability Strategic Plan".

[12] "Community Sustainability Advisory Board | City of Golden, Colorado." Accessed: Feb. 21, 2024. [Online]. Available: https://www.cityofgolden.net/government/boards-commissions/community-sustainability-advisory-board/

[13] "CSABWorkPlan.pdf." Accessed: Feb. 21, 2024. [Online]. Available: https://www.cityofgolden.net/media/CSABWorkPlan.pdf

[14] "Reso1937LEEDSilverformunibuildings.pdf." Accessed: Feb. 21, 2024. [Online]. Available: https://www.cityofgolden.net/media/Reso1937LEEDSilverformunibuildings.pdf

[15] "SustainabilityMenu.pdf." Accessed: Jan. 31, 2024. [Online]. Available: https://www.cityofgolden.net/media/SustainabilityMenu.pdf

[16] "Project Certification Overview | Phius Project Certification Overview." Accessed: Feb. 21, 2024. [Online]. Available: https://www.phius.org/certifications/projects/project-certification-overview

[17] "About Our Office." Accessed: Feb. 29, 2024. [Online]. Available: https://www.denvergov.org/Government/Agencies-Departments-Offices/Agencies-Departments-Offices-Directory/Climate-Action-Sustainability-Resiliency/About

[18] O. of C. A. Resiliency Sustainability and, "Creating a sustainable, resilient and climate-safe Denver," ArcGIS StoryMaps. Accessed: Feb. 29, 2024. [Online]. Available: https://storymaps.arcgis.com/stories/7a9f1f7fb63a44ef80312eb62aa2368b

[19] "Certifiably Green Denver." Accessed: Feb. 29, 2024. [Online]. Available: https://www.denvergov.org/Government/Agencies-Departments-Offices/Agencies-Departments-Offices-Directory/Climate-Action-Sustainability-Resiliency/Cutting-Denvers-Carbon-Pollution/Community-Engagement/Certifiably-Green-Denver
[20] "cpf_fiveyearplan_final.pdf." Accessed: Feb. 29, 2024. [Online]. Available: https://denvergov.org/files/assets/public/v/2/climate-action/cpf_fiveyearplan_final.pdf
[21] "Energize Denver Hub - Existing Buildings." Accessed: Feb. 29, 2024. [Online]. Available: https://www.denvergov.org/Government/Agencies-Departments-Offices/Agencies-Departments-Offices-Directory/Climate-Action-Sustainability-Resiliency/Cutting-Denvers-Carbon-Pollution/High-Performance-Buildings-and-Homes/Energize-Denver-Hub
[22] "green-buildings-ordinance.pdf." Accessed: Mar. 01, 2024. [Online]. Available: https://www.denvergov.org/files/assets/public/v/1/community-planning-and-development/documents/ds/gbo/green-buildings-ordinance.pdf
[23] "2022 DENVER GREEN CODE | ICC DIGITAL CODES." Accessed: Apr. 03, 2024. [Online]. Available: https://codes.iccsafe.org/content/CODGC2022P2/chapter-1-scope-and-administration
[24] "Lakewood Sustains." [Online]. Available: https://www.lakewood.org/files/assets/public/v/1/planning/comprehensive-planning/pdfs/community-plans/comp-plan/lakewood-2025_moving-forward-together_9_final_sustains.pdf
[25] "enhanced-development-menu-applicant-resource-guide-march-2021.pdf." Accessed: Feb. 21, 2024. [Online]. Available: https://www.lakewood.org/files/assets/public/v/2/planning/development-assistance/pdfs/development-handouts/enhanced-development-menu-applicant-resource-guide-march-2021.pdf
[26] "Office of the Federal Chief Sustainability Officer." Accessed: Mar. 07, 2024. [Online]. Available: https://www.sustainability.gov/index.html
[27] "Guiding Principles for Sustainable Federal Buildings and Associated Instructions".
[28] "Checklist: LEED v4 for Building Design and Construction | U.S. Green Building Council." Accessed: Nov. 14, 2023. [Online]. Available: https://www.usgbc.org/resources/checklist-leed-v4-building-design-and-construction
[29] "Optimize Energy Performance | U.S. Green Building Council." Accessed: Nov. 22, 2023. [Online]. Available: https://www.usgbc.org/credits/new-construction-core-and-shell-warehouse-and-distribution-centers-new-construction?return=/credits/New%20Construction/v4.1/Energy%20&%20atmosphere
[30] "Minimum Energy Performance | U.S. Green Building Council." Accessed: Nov. 28, 2023. [Online]. Available: https://www.usgbc.org/credits/new-construction-core-and-shell-schools-new-construction-retail-new-construction-data-21?return=/credits/New%20Construction/v4.1/Energy%20&%20atmosphere
[31] G. R. Newsham, S. Mancini, and B. J. Birt, "Do LEED-certified buildings save energy? Yes, but…," *Energy Build.*, vol. 41, no. 8, pp. 897–905, Aug. 2009, doi: 10.1016/j.enbuild.2009.03.014.
[32] "LEED-v5-OM-Existing-Buildings-beta-version_1.pdf."
[33] K. Clay, E. Severnini, and X. Sun, "Does LEED certification save energy? Evidence from retrofitted federal buildings," *J. Environ. Econ. Manag.*, vol. 121, p. 102866, Sep. 2023, doi: 10.1016/j.jeem.2023.102866.

[34] F. Greer, J. Chittick, E. Jackson, J. Mack, M. Shortlidge, and E. Grubert, "Energy and water efficiency in LEED: How well are LEED points linked to climate outcomes?," *Energy Build.*, vol. 195, pp. 161–167, Jul. 2019, doi: 10.1016/j.enbuild.2019.05.010.
[35] "Understanding the changes: LEED 2009 to LEED v4.1 | U.S. Green Building Council." Accessed: Apr. 11, 2024. [Online]. Available: https://www.usgbc.org/resources/understanding-changes-leed-2009-leed-v41
[36] W. G. Expert Rise Renewable Energy, "What Is an HRV or ERV System?," Rise. Accessed: Apr. 14, 2024. [Online]. Available: https://buildwithrise.com/stories/hrv-and-erv
[37] "Renewable energy production | U.S. Green Building Council." Accessed: Nov. 14, 2023. [Online]. Available: https://www.usgbc.org/credits/new-construction-core-and-shell-schools-new-construction-retail-new-construction-data-44?return=/credits/New%20Construction/v4/Energy%20&%20atmosphere
[38] "Renewable Energy | U.S. Green Building Council." Accessed: Nov. 13, 2023. [Online]. Available: https://www.usgbc.org/credits/new-construction-core-and-shell-schools-new-construction-retail-new-construction-data-34?return=/credits/New%20Construction/v4.1/Energy%20&%20atmosphere
[39] "LEED-v5-BDC-New-Construction-Public-Comment-1.pdf." Accessed: Apr. 14, 2024. [Online]. Available: https://www.usgbc.org/sites/default/files/2024-04/LEED-v5-BDC-New-Construction-Public-Comment-1.pdf

Appendix

Appendix A - Sample LEED Checklist [28]

LEED v4 for BD+C: New Construction and Major Renovation
Project Checklist

Project Name:
Date:

Y	?	N			
			Credit	Integrative Process	1

0	0	0	**Location and Transportation**		**16**
			Credit	LEED for Neighborhood Development Location	16
			Credit	Sensitive Land Protection	1
			Credit	High Priority Site	2
			Credit	Surrounding Density and Diverse Uses	5
			Credit	Access to Quality Transit	5
			Credit	Bicycle Facilities	1
			Credit	Reduced Parking Footprint	1
			Credit	Green Vehicles	1

0	0	0	**Sustainable Sites**		**10**
Y			Prereq	Construction Activity Pollution Prevention	Required
			Credit	Site Assessment	1
			Credit	Site Development - Protect or Restore Habitat	2
			Credit	Open Space	1
			Credit	Rainwater Management	3
			Credit	Heat Island Reduction	2
			Credit	Light Pollution Reduction	1

0	0	0	**Water Efficiency**		**11**
Y			Prereq	Outdoor Water Use Reduction	Required
Y			Prereq	Indoor Water Use Reduction	Required
Y			Prereq	Building-Level Water Metering	Required
			Credit	Outdoor Water Use Reduction	2
			Credit	Indoor Water Use Reduction	6
			Credit	Cooling Tower Water Use	2
			Credit	Water Metering	1

0	0	0	**Energy and Atmosphere**		**33**
Y			Prereq	Fundamental Commissioning and Verification	Required
Y			Prereq	Minimum Energy Performance	Required
Y			Prereq	Building-Level Energy Metering	Required
Y			Prereq	Fundamental Refrigerant Management	Required
			Credit	Enhanced Commissioning	6
			Credit	Optimize Energy Performance	18
			Credit	Advanced Energy Metering	1
			Credit	Demand Response	2
			Credit	Renewable Energy Production	3
			Credit	Enhanced Refrigerant Management	1
			Credit	Green Power and Carbon Offsets	2

0	0	0	**Materials and Resources**		**13**
Y			Prereq	Storage and Collection of Recyclables	Required
Y			Prereq	Construction and Demolition Waste Management Planning	Required
			Credit	Building Life-Cycle Impact Reduction	5
			Credit	Building Product Disclosure and Optimization - Environmental Product Declarations	2
			Credit	Building Product Disclosure and Optimization - Sourcing of Raw Materials	2
			Credit	Building Product Disclosure and Optimization - Material Ingredients	2
			Credit	Construction and Demolition Waste Management	2

0	0	0	**Indoor Environmental Quality**		**16**
Y			Prereq	Minimum Indoor Air Quality Performance	Required
Y			Prereq	Environmental Tobacco Smoke Control	Required
			Credit	Enhanced Indoor Air Quality Strategies	2
			Credit	Low-Emitting Materials	3
			Credit	Construction Indoor Air Quality Management Plan	1
			Credit	Indoor Air Quality Assessment	2
			Credit	Thermal Comfort	1
			Credit	Interior Lighting	2
			Credit	Daylight	3
			Credit	Quality Views	1
			Credit	Acoustic Performance	1

0	0	0	**Innovation**		**6**
			Credit	Innovation	5
			Credit	LEED Accredited Professional	1

0	0	0	**Regional Priority**		**4**
			Credit	Regional Priority: Specific Credit	1
			Credit	Regional Priority: Specific Credit	1
			Credit	Regional Priority: Specific Credit	1
			Credit	Regional Priority: Specific Credit	1

0	0	0	**TOTALS**	**Possible Points:**	**110**

Certified: 40 to 49 points, **Silver:** 50 to 59 points, **Gold:** 60 to 79 points, **Platinum:** 80 to 110

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Nathan is a Senior undergraduate student in the Design Engineering program under Engineering, Design and Society. Growing up, Nathan always loved architecture and was fascinated by renewable energies, and quickly found a home in Mines' Solar Decathlon & Tiny House club. Nathan has served as Secretary, Tiny House Vice President, and President of the club, and they have also designed sustainable residential buildings through two Solar Decathlon competitions, one of which Nathan was the Director of Design. As a Sustainability Intern, and incoming Sustainability Consultant, Nathan also has experience in green building rating systems like LEED, WELL, the Living Building Challenge, and CHPS, as well as local green building codes.

Under the instruction of Dr. Jessica Smith in classes like Community-Based Research and Energy & Society, Nathan has also explored the intersection of marketing, sustainability, and engineering to understand how universities and organizations like USGBC shape the public perception of how we are making the world more sustainable. Nathan has combined their technical, sustainability, and social science expertise into a Capstone Design project proposing how the Colorado School of Mines can decarbonize their electricity usage while also providing energy justice measures to nearby communities, students, faculty, and administration. Nathan is graduating with distinctions in Sustainable Energy @ Mines and Leadership in Humanitarian Engineering.

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