CHAPTER 6

Information or Marketing? Lessons from the History of Private-Sector Green Building Labelling

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1 Introduction

Amenities, architectural features, aesthetics, floorplate layouts, fit-outs, communal space quality, ownership titles, existing lease contracts, and forecasted cash flows are some of the visually or textually informative features prospective owners or occupiers of property can use when making buying or leasing decisions. Confidence in the local regulatory authority's ability to enforce building codes implies additional information associated with structural, health, and safety attributes. "Green" buildings are natural resource efficient spaces that do not pollute the biophysical environment. These attributes are invisible; thus, an absence of information on resource flows or pollutant emissions during the buying or leasing process may be

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responsible for local and global environmental degradation. “Sustainable” building advocates seek to expand the scope of information not available to the market to include social objectives such as human health, distributional economic justice, and community-building (Cole, 2012). One proposed solution is the same for both green and sustainable building: provide the missing information and the market will value and thus supply buildings with these attributes.

This market-based solution has developed into a private industry developing and managing third-party green building assessment tools. The general mechanism is that an applicant (i.e. building owner) pays a fee to the certifying firm and provides evidence within a pre-defined framework developed by the certifying firm to measure the invisible attributes of green buildings. Next, the certifying firm accredits auditors tasked with reviewing the application, verifying the supporting documentation, and establishing the credibility of the label. Sign-off from the review means the building owner can advertise a green building credential to all interested parties.

One purpose of this chapter is to argue that while there appears to be a wide diversity of private certification labels and schemes in the global property market (Christensen & Sayce, 2015; Reed, Bilos, Wilkinson, & Schulte, 2009), these can be simplified into two primary methods of certification based on the assessment strategy. We distinguish between “voluntary environmental building codes” and “measured building performance auditing”. Voluntary environmental building codes reward applicants for exceeding statutory minimums associated with protecting the biophysical environment and, in most examples, human health. These systems seek to measure potential outcomes and apply to buildings pre-occupancy. This method was the predominant, often exclusive, method in the early years (1990s and 2000s) of green building labelling. Notable voluntary environmental building codes include the new construction modules of Leadership in Energy and Environmental Design (LEED), the Building Research Establishment Environmental Assessment Method (BREEAM), and Green Star.

Measured building performance auditing meets demand for continuous assessment during occupancy and facilitates labelling of the (much larger) population of existing buildings not undergoing major renovations. This approach typically involves a 12-month audit of operational data associated with direct or indirect environmental impacts.

The current state of green building labelling is shifting from conserving the biophysical environment to promoting human health and wellness. Such a pivot is not entirely novel; health is the reason many voluntary environmental building codes include credits for enhancing the indoor environment. However, a private firm, Delos Living, has recently demonstrated success with its WELL Building standard, which follows the voluntary environmental building code model but exclusively contains design guidelines associated with human health and wellness. A potential growth market for the labelling industry is for a building owner to undergo separate environmental and wellness assessments, as Delos Living suggests in its marketing materials.

A critical evaluation of the first two decades of the application of private green building assessment tools results in four findings. First, early pioneering users of a voluntary green building code behave as if they were complying with a statutory building code—an incentive to do the minimum required. Second, we review the widespread claim that labelled buildings are associated with increased market valuations. Third, data from Green Star Australia complements a robust literature demonstrating that post-occupancy evaluations in labelled buildings indicate these buildings are more average in-use than design-stage ratings imply. Finally, there is early research demonstrating how repetitive participation in a measured building performance auditing scheme produces rapid improvement in environmental outcomes.

We use our four findings from the critical evaluations above to reflect on the challenges facing green building labelling. Specifically, we reflect on how to improve effectiveness, increase adoption, harmonise benchmarking, and integrate design with operation. We argue that a life-cycle approach to green labelling built around a measured building performance auditing regime addresses these challenges. However, there are institutional and incentive barriers to this solution. The literature shows that the label itself is what delivers value; perception matters more than performance. In such a market, there is an associated cost to negative perceptions such as a rating downgrade or rating disqualification, so private certification firms eliminate this risk by allowing certification to be optional and, in most cases, last forever.[1]

[1] For example, should a building owner fail to obtain auditing sign-off, her building remains uncertified, a relatively neutral outcome. On the other hand, should the building have a bad year from a performance perspective, most measured building performance audit-

The emerging challenge for the private-sector is to champion commitment to a certification lifecycle (design → construction → operation) and create a marketing environment where such "deep" and continuous commitment stands out above those that only participate when the narrative or scheme suits their interests. However, given the private disincentive to integrate, we explain how mandatory disclosure regulation is the key to overcome these barriers and align incentives for successful integration between building designers and users.

2 Voluntary Environmental Building Codes

Beginning with the United Kingdom BREEAM in 1990, voluntary design- and construction-stage assessment schemes serve to differentiate buildings—usually commercial office buildings—that exceed local building code standards associated with the biophysical environment and human health. Using these optional standards, building owners obtain third-party certification for a building that conserves natural resources (energy, water, and materials), creates a healthy indoor environment, and enhances the quality of the biophysical environment. With differentiation in the market, economic theory suggests that if the market values enhanced environmental (or health and wellness) attributes, certified buildings will obtain value premiums (Fuerst & McAllister, 2011a).

There are hundreds of private green building certification systems in use today (Reed et al., 2009). We observe that most are regionally specific modifications of the framework established by BREEAM,[2] varying mainly through reference to regionally specific institutional and regulatory practices. We coin the term "voluntary environmental building code" to refer to the BREEAM framework and the hundreds of certification tools that follow its philosophy. This term recognises that the birth of the BREEAM framework was within a firm tasked with reviewing the building code; hence, it is unsurprising that its foundational philosophy was identifying buildings that exceed code minimums. In reviewing many of the schemes described in more depth by Reed et al. (2009) and Ding (2008), we

ing tools will award her building a low grade (say, 0 stars out of 6), conveying a negative, rather than neutral, message of differentiation.

[2] In this section, when we say "BREEAM" it more specifically refers to all BREEAM modules except In-Use.

observe that the following attributes are commonly associated with a voluntary environmental building code:

- Applicants receive a "point" (or "credit") for exceeding a building code or other statutory compliance requirement to a predetermined degree.
- Points are designed to maintain or enhance the quality of the biophysical environment, with a small fraction designed to enhance the quality of the internal environment for human health and wellness outcomes.
- Assessments occur at a pre-occupancy phase in the building lifecycle.
- Points associated with performance in-use are estimated using mathematical models or simulations to represent the potential of a building design.
- The majority of points are optional, with an overall "greenness" label determined by a randomly chosen percentage of optional points obtained.
- A "green building council"—a private firm supported by local design, construction, and property industry membership—typically manages the certification scheme and licences independent assessors to oversee compliance with the scheme.
- Participation in the certification process is not mandated by local building codes.
- Once issued by the independent assessor, a label has no expiration date.

The core philosophy of the voluntary environmental building code is to serve as an instrument for building designers to compare environmental (or health and wellness) **potential** between building designs. Potential in this context is best defined as "assuming normal or default patterns of occupant behaviour and building operation, making it easier to distinguish between improvements in the physical features and improved efficiencies in use and operation" (Cole, 1999).

Naturally, there are minor exceptions to the characterisation described earlier given the global diversity of assessment tools. The most common deviation occurs when local building codes mandate the achievement of a private green building certification, though Schindler (2010) finds this practice to be declining as governments learn that this practice effectively outsources management of the public building code to the private-sector. Another common deviation, which bridges the two frameworks discussed in this chapter, involves the treatment of existing buildings. When a voluntary environmental building code certifies an existing building—which occurred before BREEAM In-Use and other tools using a hybrid philosophy gained market traction—the subject building was assessed as if it was not occupied. This enabled the assessors to apply the philosophy that an assessment should evaluate building design potential, rather than building performance in-use. However, as we discuss later, the ability to measure actual existing building performance and the recognition that operational practice can result in significant deviations from design potential spurred on the development of separate hybrid labelling frameworks for existing buildings.

The following sections describe the scope of a voluntary environmental building code in more depth through the history of BREEAM and the LEED, the US-based tool. These two schemes are the oldest and most recognisable brands for voluntary environmental building codes and both are offered worldwide—the closest the industry has to a global standard for sustainable building design. Our discussion concludes with a section on other tools of note: Green Star, a BREEAM variant which dominates the market in Australasia, and PassivHaus, an early energy-efficiency specific tool that started in the residential, rather than commercial, sector.

2.1 BREEAM, the Archetype

In 1990, the United Kingdom government-owned Building Research Establishment (BRE) introduced BREEAM version 1/90. As one of the creators of BREEAM, Prior (1991) describes the growing public concern regarding damage to the global environment, poor indoor air quality, and the need to raise awareness of the large contribution by the property sector to these problems as motivation for developing the certification scheme. In the late 1990s, BRE was privatised, with management of BREEAM as one of its core businesses.

BREEAM assesses a building design by the degree to which it exceeds contemporary regulatory standards concerning "global-scale", "neighbourhood-scale", and "internal environment" indicators. Global- and local-scale concerns include enhancing the biophysical environment and mitigating ecological degradation while internal environment concerns included indoor air pollutants and their effect on human health

(Prior, 1991). It is important to understand that, because subsequent voluntary environmental building codes follow this framework, common understanding of green labelling as a holistic concept continues to include enhancement of human health and wellness, even though this has no impact directly on the biophysical environment.

Building developers seeking BREEAM certification use a checklist of compliance standards and gain one credit for meeting each individual standard. In BREEAM 1/90, the “greenness”—or depth of environmental quality—of the asset was measured by the total number of credits awarded; more credits indicated a “greener” asset. Later revisions to BREEAM increased the number of credits and created easy-to-understand adjective-based labels—“Pass”, “Good”, “Very Good”, “Excellent”, and “Outstanding”—that serve to communicate the depth of environmental quality based on the percentage of applicable credits awarded. Over the past 25 years, BREEAM has also grown in scope, expanding the list of standards associated with credits, the types of buildings that can be certified, sub-components of building structures that can be certified, where buildings could be certified, and the time in the design and construction process when certification can occur.

The first growth in the scope of BREEAM occurred through developing a larger list of environmental and health standards associated with credits. BREEAM 1/90 had a maximum of 25 credits, assessing potential greenhouse gas emissions from operational use, ozone depleting emissions, responsible wood product sourcing, provision of space for sorting recyclable materials, exposure to legionnaire’s disease, site selection, indoor lighting quality, use of hazardous materials, and indoor air quality (Prior, 1991). In its current form, BREEAM 2016, there are a maximum of 150 credits across the suite of credit areas that includes building management practices, human health and well-being, hazard mitigation, operational energy efficiency, transport choices, water efficiency (including stormwater management), material selection, waste management, land use/ecology, pollution mitigation, and bespoke credits awarded for innovative design decisions (BRE Global, 2016). However, it is important to note that, while the list of standards has grown, the original three-tiered approach of global, neighbourhood, and internal environmental concerns remains the framework behind BREEAM.

Originally developed for office building designs, BREEAM has since developed a large portfolio of application methodologies to accommodate other building typologies. As of 2016, BREEAM has specific guidelines covering residential buildings (single-family, multifamily, long-term stay), commercial buildings (office, industrial, retail), educational campus buildings, and hotels (BRE Global, 2016). In addition, BRE offers to assess any building typology or civil infrastructure project in any global location on a bespoke basis.

The third growth strategy involved offering certification outside the United Kingdom. At first, BRE licenced their rating methodology for adaptation to firms in foreign countries. Hong Kong's Building Environmental Assessment Method (HK-BEAM) and Australia's Green Star are two frequently studied labelling schemes that began by licencing BREEAM and adapting it for local markets. Later, as BREEAM grew its own brand value, BRE created a BREEAM Europe rating scheme in 2008 (for systematic certification of buildings across the continent), followed by the launch of BRE Global, a division that offers to certify any building in any country with the BREEAM brand (BRE Global, 2013).

Another scope of growth involves offering certification for partial building components. BREEAM 1/90 could only assess a whole building, but to meet demand from developers that delivered speculative buildings with no fit-out, BREEAM developed a "Shell" and "Shell and Core" rating context. "Shell" refers only to the building envelope, internal partitions, and structural floors. "Core" includes centralised building services (lifts, mechanical systems, utilities) while excluding tenancy-specific fit-outs.

BREEAM also expanded when an assessment occurred in the building life-cycle: design, construction, in-use, or under refurbishment. Originally, BREEAM 1/90 was a checklist of design standards, so assessment occurred during the design phase. Prior (1991) describes the design assessment in BREEAM 1/90 as appropriate because this stage provided the best opportunity for improvements and changes. However, very few buildings are built exactly to design specification. It is common for significant changes to occur during construction management (e.g. perhaps the timber supplier no longer has sufficient stock of certified wood). To ensure delivery of green buildings in line with design expectations, BREEAM now refers to design-only ratings as "interim"; full certification is withheld until the assessor reviews documentation associated with the construction phase (BRE Global, 2016). Refurbishments and fit-outs do not have the same blank canvas as a new building, thus BRE offers a separate set of optional standards for this phase, which matches the project (say, an internal remodelling plan) with a subset of relevant BREEAM standards, much in the same manner as the Core and Shell certification scope operates.

Finally, the In-Use certification method for existing buildings not undergoing major refurbishment is a special exception to the voluntary building code model used by BREEAM. As is described later, BREEAM In-Use is a hybrid system that applies measured building performance audits when possible; it is not entirely a voluntary environmental building code.

The methodology, scope, and growth strategy of BREEAM serves as a template for the development of similar voluntary environmental building codes across the globe. Reviews of the emergence of green building certification in the 2000s narrate the breadth and depth of global market penetration for voluntary environmental building codes modelled on BREEAM (Cole, 2006; Ding, 2008; Reed et al., 2009; Sayce, Sundberg, & Clements, 2010). During this period of rapid growth, the success of BREEAM attracted its primary competitor in the global certification market, the LEED scheme developed in the United States.

2.2 LEED

Following its launch in 2000, the suite of tools under the LEED brand, developed by the industry-led United States Green Building Council (USGBC), began as the dominant voluntary environmental building code in the United States. Like BREEAM, it has since expanded to become a global brand.

LEED's earliest assessment method covered the construction of new office buildings. This flagship rating system, currently named LEED for Building Design and Construction (BD+C) is now in its fourth version (USGBC, 2017). It adopts the BRE philosophy of collating optional building standards associated with improving the quality of the global, local, and internal environment. It uses an increasingly precious metals scale of "Certified", "Silver", "Gold", and "Platinum" to label the relative sustainability of a building within the scheme. Like BREEAM's adjectives, these thresholds are associated with the percentage of optional credits met, with the lowest LEED benchmark consistently associated with meeting at least 40% of all optional credits along with a small number of required prerequisite actions.

Much of the earlier discussion on BREEAM also applies to LEED, particularly the agenda for incremental growth in optional credits, building types, construction phases, and global applications. Advocates of BREEAM or LEED may wish to engage in debate over which one was first to market with, say, the idea for an assessment just on the core and shell of a building, but in a market environment where it is easy to copy strategy, such claims are trivial to green building outcomes. However, there are three key areas where LEED has shaped the evolution of modern voluntary environmental building codes: the elimination of the design-only certificate for buildings, the expansion of scope into additional social outcomes through its Neighborhood Development module, and the hybrid approach to certifying existing buildings.

While BREEAM began with design-stage certification, LEED has never offered a building certification prior to completed construction. Version 1 of BD+C (then called “LEED for New Construction” or LEED-NC) in 2000 only offered certification on evidence associated with a building as-built. That philosophy continues, though the USGBC does allow aspiring projects in the design or construction phase to advertise that they have been “registered” for a particular certification that will be formally assessed upon completion.

The minor deviation from LEED’s philosophy of as-built (or later) stage certification is the decision by the USGBC to expand the application of LEED into urban planning at the neighbourhood development scale. Owing to development timelines that can be much longer than the construction of a single building, the USGBC allows developers to obtain LEED for Neighborhood Developments (LEED-ND) certification once the developer has received full construction entitlements from a permitting authority. However, of greater interest to this narrative is the expanded scope of LEED-ND credits that contribute to the history of voluntary environmental building codes. LEED-ND expands the outcome scope of a voluntary green building code beyond the BREEAM building-archetype of global/local biophysical environmental quality and human health. Socioeconomic outcomes attract credits in LEED-ND, notably design attributes that promote universal accessibility, community engagement, food production, building type diversity, and the provision of affordable housing. This expanded scope is one of the earliest attempts at a built environment rating scheme applying the full traditional model of sustainability that includes environmental, social, and economic outcomes. BREEAM followed LEED-ND with its Communities scheme that mimics its expanded scope and, befitting the strategy of BREEAM, includes the option to certify earlier in the development process. Sullivan, Rydin, and

Buchanan (2014) review the emergence of neighbourhood-scale certification schemes in depth.

LEED has also been instrumental in offering certification to existing buildings not undergoing major renovations. Version 2 of LEED (USGBC, 2004) includes a certification scheme for existing buildings that was largely a voluntary environmental building code based on LEED-NC, but with a few credits rewritten to require in situ performance evaluations rather than simulated potential performance. Notably, buildings were required to undergo self-evaluation using the Energy Star methodology, a measured environmental performance audit, in lieu of simulating energy consumption. This strategy matured in LEED for Building Operations and Maintenance (LEED O+M), which was the earliest hybrid certification scheme that combines both philosophies of building certification discussed in this chapter and, importantly, provides the potential to inform the market across all stages of a building's life-cycle (Christensen, 2011).

Looking to future innovations, the USGBC has taken interest in the problem of operational deviation from design potential (see Sect. 5.3 later) and developed implicit incentives for building designers to work with future building users. In LEED BD+C 2009 (the third major revision), the USGBC encouraged building owners to share operational data with the USGBC. Operational data sharing became mandatory with the fourth major revision in 2016. Another innovative idea from the 2016 revision of LEED BD+C is the option for the design team to substitute a post-occupancy measured energy consumption audit as an alternative compliance path to simulating building energy consumption potential of the as-built structure. While this alternative compliance path may not entice many project teams (because waiting for the post-occupancy data can delay the final certification by up to two years post-construction), it provides a signal for designers to work with users, one of the major recommendations we make later in this chapter.

2.3 Green Star Australia and New Zealand

The Australian Green Star voluntary environmental building code began as a version of BREEAM licenced to the Green Building Council of Australia (GBCA). Following translation of the BREEAM credits to the professional and regulatory Australian building context, the GBCA rebranded the label as Green Star. Besides the translation, the key difference between BREEAM and Green Star is the labels; instead of the

BREEAM suite of adjective-based labels, Green Star takes its name from awarding a building between one and six "Green Stars" based on the percentage of relevant credits obtained. Zero stars signify statutory minimums for any building. Formal green building labels are offered to any building qualifying for 4, 5, or 6 Green Stars, representing compliance with 45%, 60%, or 75% of applicable credits.[3]

GBCA currently manages Green Star rating modules for new commercial buildings (Green Star Design, Green Star As-Built), commercial buildings in-use (Green Star Performance), commercial building fit-outs (Green Star Interiors), and community planning (Green Star Communities).[4] With the exception of Green Star Performance, a multi-attribute measured building performance auditing scheme, all Green Star labelling tools are voluntary environmental building codes.

GBCA licenced Green Star to the New Zealand Green Building Council (NZGBC), which manages its own suite of labelling tools referred to as Green Star NZ. NZGBC certifies new commercial buildings (design or as-built stages), new residential homes (Homestar), and commercial buildings in-use (office energy consumption only). Both green building councils only certify buildings in their respective countries as Green Star Australia and Green Star NZ are managed separately.

A particularly notable contribution in the evolution of voluntary environmental building codes is the Australian Green Star Communities rating system. Following the USGBC's novel attempt at integrating social, environmental, and economic outcomes in a single sustainability rating, GBCA borrowed from existing neighbourhood-scale certification systems, such as BREEAM Communities and LEED-ND, but sought to further expand the evaluation of social and economic outcomes associated with the planned neighbourhood (GBCA, 2015). Additions to the LEED-ND framework include credits for celebrating local heritage/cultural identity, planning for economic resilience through diverse employment/educational opportunities, measuring investment return, and the provision of digital infrastructure.

[3] 1, 2, and 3 Green Star achievements can be formally certified in the operational Green Star Performance scheme.

[4] The market for residential voluntary environmental building code certification in Australia is led by NatHERS (Nationwide House Energy Rating Scheme). This is an energy simulation similar to PassivHaus that estimates the energy efficiency of a housing design.

2.4 *Voluntary Environmental Building Codes for the Residential Sector*

BREEAM, LEED, and Green Star primarily serve the demand of the commercial-institutional (non-residential) building industry for voluntary environmental building codes. Though each has schemes available to certify residential property, these labels are not as widely adopted nor as widely studied in the literature. Instead, popular labelling schemes in green residential property, particularly single-family units, often take a much narrower, energy-centric, view that follows in the framework of the PassivHaus (Passive House) method developed in Germany around the same time as BREEAM.

Like the rating schemes described earlier, PassivHaus is a voluntary environmental building code, and the PassivHaus Institut (PHI) offers certification with its standard worldwide. But what makes it different from the BREEAM archetype is that PassivHaus only exists to evaluate energy efficiency, particularly demand for space conditioning. There are just three criteria for certification: a space conditioning (heating or cooling) demand of not more than 15 kWh/m^2/year (simulated), an airtightness performance threshold (measured on-site), and a total non-renewable primary energy consumption limit (<120 kWh/m^2/year originally). Certification was originally a binary outcome and a house must meet all three criteria along with less specific best practices on user controls and humidity. In 2015, PHI altered its renewable energy criteria to allow for differentiation between certified Passive Houses. Labels of "Classic", "Plus", and "Premium" now exist to identify properties that fall below specific thresholds of total non-renewable primary energy consumption and on-site renewable energy generation (PHI, 2016). PHI has also developed a rating scheme for labelling retrofits of existing houses and can amend their criteria for use in non-domestic commercial properties. In addition, a PHI "Low Energy Building Standard" was developed for buildings that fall shy of the strict space heating standard.

The PassivHaus approach to engineering standards for low energy buildings has become an archetype for residential energy certification in much the same manner as BREEAM became an archetype for voluntary environmental building codes in the commercial sector. Most notably, energy simulations of housing energy efficiency are being adopted as quasi-regulations by some governments. Members of the European Union (EU) must produce an Energy Performance Certificate (EPC) when offering residential property and, increasingly, certain types of non-residential property for sale. Despite the word "performance" in its name, an EPC is a simulation of an existing house structure that closely resembles the narrow scope of a PassivHaus certification. The objective of an EPC is not to mandate a stringent threshold like the PassivHaus but rather as a tool for prospective users to compare energy efficiency potential of houses on the market. Another example is NatHERS, the Australian Nationwide House Energy Rating Scheme. This rating system is managed by the federal Australian government for use by states, which apply NatHERS either on a voluntary basis, integrated into a state building code, or made quasi-mandatory in a similar manner to the European EPC directive. The institutional presence of NatHERS in the Australian market is one likely reason why Green Star Australia does not currently offer a voluntary environmental building code certification scheme for single-family homes.

3 Measured Building Performance Auditing

The philosophy of voluntary environmental building codes is the creation of a benchmark to compare the potential performance of buildings, an indicator of use to those in the design, development, and construction industry. However, this philosophy means little to those with an interest in how the building is operating. For example, facility managers, investment asset managers, and building occupants may wish to differentiate their businesses based on the actual performance of their building or tenancy. Importantly, not all high-spec buildings with great sustainability potential actually operate to such high standard. Vale and Vale (2009) discuss how user behaviour can quickly eliminate the best intentions of a building designer. Labelling schemes using a framework we call "measured building performance auditing" have emerged to fill the niche for assessing and informing the market on indicators of sustainable operation.

In theory, measured building performance auditing is an accounting exercise with three key steps. First, the firm (or, often, government agency in a quasi-private capacity) managing the labelling scheme produces a framework for the accounts, which is effectively a sustainability equivalent to a financial accounting framework such as the Generally Accepted Accounting Principles (GAAP) in the United States. Successful frameworks for measured building performance auditing enable fair comparison between building ratings, usually adjusting raw performance data by building use type (office, residential, industrial, etc.), building use intensity (hours of operation, occupant density, etc.), size, and location. Often, before certification can commence, there is a thorough market survey of average building performance across all adjustment categories used to calibrate the accounting framework. Second, the firm licences auditors to evaluate empirical performance data for buildings' that choose to apply for labelling using the accounting framework. Third, the results of the audit are relevant only to the period under audit, so regular audits, and re-benchmarking, are required to keep the public up-to-date. This final step in particular deviates from the assessment process associated with voluntary environmental building codes, which have no label expiration date and do not subject the building owner to future, more stringent, standards.

There are two archetypes popular for measured building performance auditing: single attribute and multi-attribute. A "single attribute" account assesses one performance outcome, most commonly operational energy consumption or greenhouse gas emissions resulting from operational energy consumption. Using a single performance indicator removes the issue of weighting between two dissimilar attributes, meaning the difficult decisions are limited to the data adjustment process, to enable fair comparison, and the boundary for data collection. The US Energy Star certification scheme is one of the earliest examples of this approach.

The other accounting framework is a "multi-attribute" account that behaves as a hybrid between voluntary environmental building codes and the single attribute accounts. This approach emerged via growth within the firms that manage voluntary environmental building codes and demand from industry for a broader scope than just a single attribute. In theory, the existence of a multi-attribute system on the market enables a building to be labelled at all three phases of the building life-cycle: design, construction, and operation.

To describe the practice of measured building performance auditing in more depth, this section describes three of the most widely used and researched single attribute labelling systems before discussing the structure of a multi-attribute system.

3.1 Energy Star

The Environmental Protection Agency of the US Federal Government (USEPA) manages a broad certification regime called Energy Star (often expressed in branding as ENERGY STAR) that covers consumer products (mainly domestic appliances), homes, commercial buildings, and industrial facilities. This section discusses the commercial building module, which is entirely based on measured building performance auditing.[5] The single attribute being assessed is annual primary energy use intensity, or the total primary energy consumption for a year divided by the total floor area of the building. Primary energy can be defined as the sum of energy consumed on-site plus the energy consumed in generation and transmission of that energy to the site. Whether the energy is from a renewable or non-renewable source is not considered. Energy Star only certifies efficiency in use. Commercial building certification, which began in 1999, is available to any building within the United States or Canada.

The accounting framework developed by USEPA has become typical of subsequent single attribute energy auditing labels and the operational energy consumption credits within multi-attribute systems. According to USEPA (2014), evidence of metered site energy consumption for the whole building is collected. The completeness of the data is confirmed by an auditor, who also gathers data on the building use type(s), hours of occupancy, number of computers (as a proxy for occupant intensity), climactic conditions over the auditing year (heating degree days and cooling degree days), and floor area of the building. These latter data are used to adjust metered energy use intensity and create a fair comparison to the national benchmark survey percentiles described later. If the building falls within the top quartile of the national benchmark survey associated with energy efficiency (i.e. lowest 25% of primary energy use intensity) for its building use type, it qualifies for certification, valid for one year. Energy Star is somewhat unique in that certification is a binary outcome only for those with the best performance; many measured building performance auditing tools use a full labelling scale to communicate both good and poor performance.

In order to convert adjusted raw performance data into an easy-to-understand label, USEPA must first apply its Energy Star accounting framework to a representative sample of the entire population of buildings in order to determine thresholds for certification. This benchmarking exercise is the Commercial Buildings Energy Consumption Survey

[5] The residential homes module offers a choice of certification based either on potential or on measured performance. The method for industrial facilities is very similar to that for commercial buildings, so this discussion also applies to the less popular practice of certifying industrial facilities. By May 2017, United States Environmental Protection Agency (USEPA) had issued just over 30,000 certificates to commercial buildings in 18 years but only 175 to industrial facilities.

(CBECS) conducted by the US Energy Information Administration. CBECS is supposed to occur every five years. All current 2017 Energy Star ratings are benchmarked against the 2003 survey, meaning that a decision to certify in 2017 is based on 12 months of recent data being compared with the top quartile of buildings in 2003. Hence, with increased attention to commercial building energy efficiency, it is probable that many more than 25% can qualify for the Energy Star label 14 years later. A revised CBECS was held in 2007, but data was discarded for statistical reasons according to an April 2011 press release from the Energy Information Administration. The most recent CBECS took place in 2012, but Zatz and Burgess (2016) claim the data is unlikely to be integrated into the Energy Star labelling framework until 2018 at the earliest. Canadian applicants for Energy Star labelling are benchmarked against the 2014 Survey of Commercial and Institutional Energy Use.

Energy Star has a very broad definition of who can qualify as the assessor with authority to audit raw energy consumption data and other data required to adjust raw consumption. Anyone who qualifies as a Professional Engineer or Registered Architect in the United States or Canada can act as an Energy Star assessor; USEPA does not run its own educational programme to certify independent assessors. Indeed, on the USEPA Energy Star website, under "tips for low-cost verifications", it suggests having an in-house Professional Engineer or Registered Architect sign off on the audit.[6] Thus, Energy Star offers the potential for self-certification in lieu of traditional "third-party" certification where the auditor is independent of both the certifying organisation and the applicant.

With the exception of the allowance for self-certification, the Energy Star assessment framework is a model for other single attribute measured building performance auditing systems. In some US state and local jurisdictions, notably California, Minneapolis, New York City, and Seattle, advertising the percentile of a building against the CBECS benchmark (i.e. the Energy Star method) is now mandatory for office buildings offered for lease or sale.

[6] https://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/earn-recognition/energy-star-certification/tips-low [viewed 30 April 2017].

3.2 National Australian Built Environment Rating System

According to Bannister (2012), the New South Wales (NSW) state government in Australia sought to produce a voluntary market-based labelling tool in 1999 that measured both actual and potential greenhouse gas emissions from office buildings, but dropped the latter owing to the complexity involved. The measured building performance auditing methodology that was implemented became known as the Australian Building Greenhouse Rating (ABGR). Later, in 2006, the ABGR would be rebranded as the National Australian Built Environment Rating System (NABERS) Energy.

NABERS Energy uses a very similar accounting framework as Energy Star, with the major difference being an additional step that converts primary energy use intensity into a measure of greenhouse gas emissions intensity.[7] The NSW Office of Environment and Heritage (2013) manages NABERS and publishes the NABERS Energy accounting framework, which includes a 12 month audit of metred site energy conversion, measurement of "rateable" floor area (removing unoccupied areas from the denominator of energy use intensity), intensity of building use (hours of operation), and intensity of occupancy (number of computer workstations). Measured site energy use intensity is adjusted in a similar manner to Energy Star, with the one exception being that the climate adjustment occurs later, when referencing the benchmark survey for labelling purposes. Audits are conducted by independent third-party assessors licenced to conduct NABERS audits. Since NABERS Energy is interested in greenhouse gas emissions, adjusted site energy use intensity is translated into adjusted source greenhouse gas emissions intensity (CO_2-eq/m^2/year) before being compared with the benchmark survey to assign a label. Certification is then valid for one year from the date of the audit.

NABERS Energy star ratings reference a benchmark survey taken in 1999 when the ABGR was established.[8] The strategy is that a median

[7] Over 85% of energy used in Australian commercial buildings is sourced from electricity, so this difference is trivial from an operational energy-efficiency perspective, though it does allow fuel-switching as a strategy to improve labels.

[8] Adjustments in the primary-energy-to-greenhouse-gas-emission conversion factors in the benchmark sample changed in 2008 for some states to reflect updated knowledge of electricity emissions in those states (Mitchell, 2010).

building for each building typology in each Australian state in the survey is given a 2.5 star rating, with percentiles used to delineate intermediate half-star thresholds between 0 and 5 stars (expanded to 6 stars in August 2011). A building's adjusted source greenhouse gas emissions intensity is compared with the half-star thresholds for the comparable building type in the same state and assigned a star rating to communicate relative building performance. Unlike Energy Star, NABERS Energy assigns a star rating to all buildings undergoing the audit, good and poor, not just those in the top quartile of energy efficiency. As of early 2017, there is no publicly disclosed plan in place for an updated NABERS Energy benchmark survey, despite the most recent annual report showing that the average NABERS Energy rating (4.2), which covers over 80% of eligible office building stock (NSW Office of Environment and Heritage, 2016), is much higher than its intended calibration of 2.5. Building types eligible for NABERS certification include offices, retail centres, and hotels.

NABERS has expanded the scope of the single attribute measured building performance auditing tool in two key directions: non-energy related single attribute labels and the offer of sub-building scale audits. The original plan for NABERS was operational measurement of every category of the Green Star voluntary environmental building code (Bannister, 2012). When the NABERS labelling scheme was tendered on the market for implementation, the winning bidder (NSW Government), chose the single attribute approach as opposed to the integrated approach used by BREEAM and Green Star. As of early 2017, an existing building can be certified for its performance in four attributes: operational energy-related greenhouse gas emissions (NABERS Energy), potable water consumption (NABERS Water), waste generation (NABERS Waste), and indoor air quality (NABERS Indoor Environment). A NABERS Transport label has been proposed but has yet to be offered to the market. Only NABERS Energy and NABERS Water have achieved substantial market uptake.[9] Befitting its status as a single attribute assessment tool, ratings in each area of concern are independent and certified separately; there is no method to weight the various categories and produce a single multiple attribute NABERS rating.

[9] According to the New South Wales (NSW) Office of Environment and Heritage (2016), the number of unique Australian buildings certified at least once by the four single attribute NABERS labelling systems are 3017 in NABERS Energy, 1349 in NABERS Water, 93 in NABERS Indoor Environment, and 45 in NABERS Waste.

Three assessment boundaries exist for NABERS Energy. At the building scale, building owners can choose to disclose their greenhouse gas emissions from “Whole Building” energy use or “Base Building” energy use. The former includes all energy consumed in the building while the latter is limited to services under the owner’s control: mechanical systems, space conditioning, lifts, hot water, and common area lighting. The third boundary is the “Tenancy” scope, which is limited to a particular tenancy to measure the services under the tenant’s control: tenant equipment (computers and other plug loads), tenancy lighting, and supplementary air conditioning services specific to one tenancy. In theory, the energy consumption measured in a Whole Building rating equals the energy measured for the Base Building rating plus the sum of all energy consumption from a complete set of Tenancy ratings. Base Building is the most popular scope in the market. For the other attributes (Water, Waste, and Indoor Environment), NABERS only offers a Whole Building scope.

3.3 Display Energy Certificates

As mentioned in Sect. 2.4, member states of the EU must produce an EPC when transacting residential and some typologies of commercial property. An EPC is typically based on the framework of energy- and greenhouse gas emission-related credits in a voluntary environmental building code and thus measures design potential, not actual, energy performance or greenhouse gas emissions.

A government labelling scheme in the United Kingdom called the Display Energy Certificate (DEC) introduced a measured building performance audit label to the market in 2008 as an operational stage variant of the EPC. At the commencement of the DEC programme, valid DECs were mandatory in publicly owned buildings and offered on a voluntary basis to privately owned buildings. As far as we are aware, this arrangement remains in place as of early 2017. According Bruhns, Jones, Cohen, Bordass, and Davis (2011), the majority of the measured building performance audits (15,335) took place in “schools and seasonal public buildings”, with office buildings (3230) and university campus buildings (2637)—the other popular building typologies—obtaining a DEC. This usage distribution implies a strong bias towards uptake only through the mandate for publicly owned buildings.

According to the Department for Communities and Local Government (2008), the process of producing a DEC is a local variant of the standard measured building performance audit methodology described earlier. As with Energy Star, an assessor collects data over a year of site energy consumption, local climate degree days, building floor area, and building occupancy over the year measured. The DEC assessor then adjusts the site energy consumption for building size and the local climate, then, like NABERS Energy, converts this adjusted site energy consumption to greenhouse gas emissions for comparison with a building use type benchmark figure for labelling. All DEC ratings are valid for one year.

The accounting benchmarks for a DEC rating are managed by the Chartered Institute of Building Services Engineers (CIBSE) and are based on "old data collected in the 1980s and 1990s" (Bruhns et al., 2011, p. 37). The Bruhns et al. (2011) report claims CIBSE will be using data collected from DEC audits to improve and update these old benchmarks where necessary. Unfortunately, the DEC benchmark methodology is not the same benchmark as is used in the design-based EPC, so a DEC and EPC in the United Kingdom are not directly comparable as design forecasts (EPC) and operational accounts (DEC) even though they both use nearly identical labelling aesthetics and letter grade labels.

3.4 Multiple Attribute Rating Systems

Voluntary environmental building codes effectively exclude existing buildings. Building stock replacement rates in developed countries range between 0.66% to 3% per year (Eichholtz, Kok, & Quigley, 2010; United Nations Environment Programme, 2007), meaning that a complete transition to current non-voluntary building code performance standards could take somewhere between 30 and 130 years. Forecasts of future energy consumption for an entire building stock conclude that existing buildings have a disproportionate effect on total consumption and greenhouse gas emissions (Coffey et al., 2009). Hence there is a large market for promoting operational behaviours that improve environmental and human health outcomes, irrespective of whether the building has high potential performance or not. In addition, single attribute labelling schemes do not produce an integrated green label often demanded in the market. To respond to this demand, managers of the major voluntary environmental building codes offer multiple attribute labelling schemes that integrate operational management policies (in-use "potential") and single attribute measured building performance auditing methodologies.

Despite the possibility of a larger market relative to new construction-only, multiple attribute labelling systems are relatively unpopular. As of early 2017 only LEED, BREEAM, and Green Star Australia offer multiple attribute certifications. In all three cases, the operational phase multiple attribute rating system was last to be offered to the market and, in all three schemes, has a lower number of publicly disclosed certifications or registrations relative to the traditional voluntary environmental building codes for new construction and major renovations.

The earliest hybrid certification was LEED for Building Operations and Maintenance (LEED O+M), originally LEED for Existing Buildings, described earlier. Currently, LEED O+M uses measured building performance auditing to evaluate transportation, potable water consumption, energy consumption (via Energy Star's accounting framework), renewable energy generation, waste generation, and daylight quality. In general, LEED O+M awards small numbers of credits (1 to 2) for the observance of written building management plans, purchasing contracts, and policies, with much larger numbers of credits awarded in the areas where measured building performance auditing is required.

BREEAM In-Use and Green Star Performance follow the LEED O+M strategy of translating their voluntary environmental building code credits into credits appropriate for measurement in-use. Christensen (2011) presents a detailed comparison between LEED O+M and BREEAM In-Use. Like LEED O+M, these multiple attribute operational labelling tools also involve a combination of stated/contracted intentions and measured building performance auditing. In particular, Green Star Performance benefits from the existence of NABERS. Green Star Performance credits on energy consumption, potable water consumption, and indoor environment quality align with NABERS Energy, Water, and Indoor Environment respectively. Another feature unique to Green Star Performance is while LEED O+M and BREEAM In-Use persist with a minimum threshold for labelling ("Certified" and "Pass" ratings, respectively), Green Star Performance removes the 4-star minimum required for official certification, allowing ratings of 0, 1, 2, and 3 stars.

Beyond restructuring credits, multiple attribute labelling systems closely follow the measured building performance auditing framework because certifications are issued with expiration dates. In LEED O+M, Green Star Performance and BREEAM In-Use, certifications expire after five years and must be renewed with up-to-date measurements and strategies.

4 WELL Building Rating

In 2016, the Global Real Estate Sustainability Benchmark (GRESB) expanded its report to include a separate Real Estate Health & Well-being module.[10] The report notes health and well-being are re-emerging as opportunity areas for the real estate industry as many property companies look for competitive advantage strategies, particularly in markets with a perceived market saturation of green building labels.[11] From the occupant perspective of green labelling, firms know that of all the inputs needed to produce office-based services, human resources are the most valuable. Gabe and Gentry (2013) report on the situation of Sydney office tenants, finding that office worker salaries are nearly ten times as costly per square metre as building rents, and hundreds of times more costly than building energy consumption. Just a small increase in worker productivity from building design could be a source of efficiency gains. These gains can be shared between occupants and owners through tenant's willingness to pay higher rents for occupancy of space where employees are more productive.

WELL is the first building labelling standard that focuses exclusively on building occupants' health and well-being. Established in 2014 by Delos Living, the WELL Building Standard[12] is now administered by the International WELL Building Institute (IWBI). Building on medical and scientific research, the standard aims to help building designers and managers integrate human health and well-being features into building design and operation with the goal of improving occupants' work quality, work productivity, and reducing absenteeism. While green building labels also address some aspects of human health and wellness, WELL certification excludes any credits associated with environmental sustainability. To ensure building professionals do not neglect environmental sustainability, IWBI is collaborating with the managers of LEED, BREEAM, and Green

[10] https://www.gresb.com/sites/default/files/2016-GRESB-Health-Module.pdf [viewed 4 July 2017].

[11] Prior (1991) discusses how the development of BREEAM 1/90 included consideration of voluntary building design standards associated with improving human health and well-being. Voluntary environmental building codes and multi-attribute measured building performance auditing continue to consider human health design guidelines as a prominent module for points/credits towards a green building label. Data and claims of market saturation for green building labels can be found in NSW Office for Environment and Heritage (2016) and Robinson and McAllister (2015).

[12] WELL in capital letters refers to the branding of the certification scheme. It is not an acronym.

Star ratings to promote international awareness of health and well-being with the aim of working synergistically with these voluntary environmental building codes. As of July 2017, over 480 projects across 30 countries are registered for certification under the WELL standard.[13]

When placed in this chapter's typology of green building labelling tools, the WELL building certification is unique as the first hybrid rating tool—with some points resembling voluntary environmental building code credits (i.e. credits associated with design process, building material specifications, construction methods, and performance simulations) and some points requiring measured verification in-use (i.e. airflow rates, water quality, food offered for occupant consumption, on-site fitness opportunities, and occupant surveys). Perhaps the most notable deviation from the voluntary building code frameworks is the validity of the label. WELL certificates are required to be renewed every three years (compared with never for LEED BD+C, a voluntary building code, and five years for LEED O+M, a multi-attribute measured performance tool). Projects can register their intent to certify during design, but final audits to verify the certification can only occur once the building is in operation with at least 50% of expected occupancy (IWBI and Delos Living, 2017).

Borrowing from LEED, WELL has adopted the precious metals scale of "Silver", "Gold", and "Platinum" to identify the relative health and wellness of a building (there is not a base-level "Certified" label). Also in harmony with the LEED scale, these thresholds are calculated based on the total number of voluntary points achieved. But that is where similarities in rating strategy end. There are significantly more prerequisite features that must be achieved for a WELL certification. This means that a WELL-certified building is more homogenous in its design and operational management than a building with one of the flexible green building labels, like LEED, which have few prerequisite credits and thus more choice for the designer and/or building manager. A New or Existing Building certification includes 41 of 100 WELL points as mandatory prerequisites, while Core and Shell has 26 pre-conditions and New and Existing Interiors has 36. A WELL Silver certification can be achieved by meeting only the prerequisite points. WELL Gold requires achieving all the prerequisite features plus at least 40% of the remaining optimisation points (i.e. 24 of 59 for a new and existing building certification), while WELL Platinum requires 80% (i.e. 48 of 59 for a new and existing building certification).

[13] https://wellonline.wellcertified.com/community/projects [viewed 4 July 2017].

Currently, WELL v1 certification is available only for commercial and institutional buildings. As of mid-2017, certification was available for office, retail, educational facilities, multifamily residential and commercial kitchens (IWBI and Delos Living, 2017). It is not a requirement to certify a whole building. IWBI has identified points that apply specifically to the base building structure ("core and shell") and points that associate specifically with the design and management of occupied space ("interiors"). Combining the parts together (allowing for some overlap) results in a "whole building" WELL certification. There is no distinction between a new construction or existing building—the requirements are the same and address the full scope of project design, construction, and building operations—but whole building certifications for office buildings do require at least 90% of the total floor area to be occupied by the building owner.

Led by LEED co-founder Rick Fedrizzi, IWBI has developed a strategic array of industry alliances and collaborations to help capture international market share for the WELL Building certification and, uniquely, has invested in producing intellectual capital in an effort to understand and empirically measure the relationship(s) between building design, management, and human health. In April 2016, Delos and the Mayo Clinic launched the Well Living Lab,[14] a reconfigurable research facility built to investigate the real-world impacts of indoor environments on human health and well-being and generate evidence-based information that can be used in practical ways to create healthier indoor spaces and increase the robustness of the WELL standard. This in-house approach to certification development is unique; most green building label management bodies solely use committees of external technical experts to write scheme credits. The IWBI has also enlisted the support of major property development and management firms. In February 2016, CBRE, a global property services firm, announced plans to pursue WELL certification for at least 100 buildings associated with CBRE worldwide. This commitment to implementation has begun to influence several of the local markets in which CBRE has committed to achieving WELL standard in buildings they manage. For example, in Sydney, Australia, major property developers, managers, and occupants including Grocon, Macquarie Bank, Mirvac, DEXUS, Lendlease, and Frasers Property have all registered their intent to pursue WELL certification for some of the buildings in their portfolio.

[14] http://welllivinglab.com/ [viewed 4 July 2017].

5 Critical Review on the Efficacy of Current Systems

Fuerst (2009) and Kok, McGraw, and Quigley (2011) have documented the rapid rise in green building labelling around the world, particularly the rise of voluntary environmental building codes. Their data imply that the invention of voluntary environmental building codes has met a formerly latent demand in the market. While not as popular in the private market, the accounting frameworks of measured building performance auditing have led to the creation of a new regulatory tool in the private market: mandatory disclosure (Gabe, 2016b; Kontokosta, 2013). Hence, both labelling frameworks have a captive market and must be recognised as having contributed to reducing information asymmetries between owners, users, and potential purchasers of labelled property.

Importantly, these labelling systems enable researchers to understand how labelling frameworks are used and to evaluate resulting improvements in the health of the biophysical environment.[15] This section explores four key arguments that have emerged from empirical research on outcomes from green building labelling. First, users of a voluntary environmental building code behave as if they were complying with minimums in a statutory building code, suggesting that the label is more important than the actions performed obtaining it. Second, labelled buildings are associated with increased financial performance, though deeper investigations face a challenge to separate the marketing value of the label from the inherent value resultant from the actions performed to obtain the label. Third, potential environmental outcome estimates of buildings in the design phase are often too optimistic relative to environmental outcomes measured in use. Finally, measured building performance auditing labels have demonstrated that repetitive participation in the auditing scheme produces surprisingly rapid improvement in environmental outcomes in-use and reduction in building-to-building variance.

[15] Epidemiological studies on the relationship between green building design (or performance) and human health (or business productivity) outcomes are either anecdotal in nature or find it difficult to disentangle the number of exogenous determinants of human health (or business productivity) sufficiently to discuss the marginal effect of building design (Fisk, 2000). Hence, we discuss the much easier to measure effect of green building design on biophysical environmental quality.

5.1 *Striving for the Minimum*

One goal of the voluntary environmental building code model is to create an incentive for designers to exceed code minimum standards. While the presence of BREEAM's framework around the world has provided such incentive, research finds that labelling applicants behave in a manner befitting regulatory compliance; they strive for the minimum number of credits required to obtain a particular label.

Management scholars propose the phenomenon of "misdirected attention" that is discussed in the study of institutional motivations within regulatory schemes targeted at environmental stewardship (Hoffman & Henn, 2008). Researchers observe that regulations to fix environmental externalities can misdirect attention away from the problem and towards compliance with the written standards and codes that can result in suboptimal outcomes and potential barriers to innovative solutions (Tenbrunsel, Wade-Benzoni, Messick, & Bazerman, 1997). Anecdotes on the practice of "point mongering" (where a building design team sets its objective as the most LEED points at the lowest cost) and similar behaviours suggest users of voluntary environmental building codes have directed their attention towards the credits, rather than towards the environmental or health performance outcomes of certified buildings (Schendler, 2009).

Empirical evidence of misdirected attention and point mongering comes from our own research on the first 450 projects[16] that have been certified using early versions of LEED BD+C. There is a clear bias towards achieving the minimum number of points for the desired level of certification (Fig. 6.1). If maximising environmental and human health outcomes were the market driver of using LEED, one would expect there be no trend in Fig. 6.1 as points would vary with resource allocations, not the random thresholds of 40%, 50%, 60%, and 80% of points created by the

[16] While there are now thousands of LEED BD+C-certified buildings worldwide, studying early adopters in the context of point-scoring behaviours is most insightful because one expects this cohort to be biased towards maximising environmental outcomes. We use the first 450 buildings because from late 2006 the USGBC stopped releasing scorecards from all projects, creating potential bias in the population of LEED buildings with known point scores. To confirm that Fig. 6.1 is not aberrant from average behaviour today, a random sample of the population of all BD+C certifications with disclosed LEED scorecards up until May 2017 reveals no material change in the pattern.

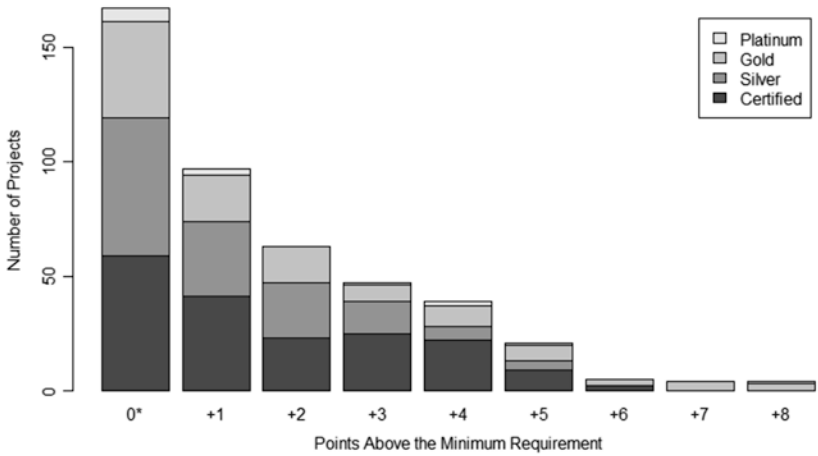

Fig. 6.1 Number of points over the minimum required for LEED certification for the first 450 certifications. Notes: Based on data from the US Green Building Council. *Includes two Silver-certified buildings that obtained less than the minimum points for a Silver certification

USGBC for labelling purposes. While Fig. 6.1 involves only the US LEED system, we find similar patterns exploring BREEAM and Green Star assessments.[17]

5.2 *Financial Returns to Labelling*

Many empirical studies have used green building labels as a "treatment" to assess a wide range of outcomes resulting from that treatment, particularly financial returns. While this research design appears sensible, it includes an important, usually unstated, limitation when applied to any multiple attribute auditing scheme. The term LEED Silver, for example, is a useful summary of a certification outcome, but it refers to a very heterogeneous label. The structure of a voluntary environmental building code like LEED

[17] LEED is more suitable for this research because it has a fixed total number of points (credits) available. BREEAM and Green Star, for example, allow designers to remove credits from the total and thus the total number of credits earned is not predictive of the label. Exploratory work from the authors on Green Star Design and Green Star As-Built disclosures in Australia confirms that early users of those labelling systems also skew to the minimum percentage of credits required.

is such that designers have wide latitude in selecting the points/credits they wish to pursue. As a hypothetical example, one building can obtain the minimum LEED Commercial Interiors points for a Silver rating by concentrating on indoor environment attributes while another building gains Silver status in LEED Building Design and Construction by designing one of the most energy-efficient building envelopes in the market. Both would be LEED Silver certified and appear to share the same label, but the intrinsic value they offer to the market is inherently different. Furthermore, the rapid scope expansion observed in BREEAM and LEED (and other voluntary environmental building codes)—particularly into partial building systems, refurbishments, interior fit-outs, and hybrid performance auditing—creates a need for the market to understand the boundaries of each rating system. Studies on financial performance have an implicit limitation that their results only measure the marketing value of a certification label, as that is the only commonality between certified projects without addressing particular activities or boundaries.

With that limitation in mind, the common narrative on the financial returns to owners of labelled buildings supports the claim that possessing a green building label enhances asset value. Most of this research has been conducted on commercial office markets and includes both voluntary environmental building codes and measured building performance audits. Research in the United States finds evidence of average/asking rent premiums, occupancy rate premiums, cap rate reductions, and sales price premiums for LEED and Energy Star labelled buildings (Eichholtz et al., 2010; Fuerst & McAllister, 2011a; Miller, Spivey, & Florance, 2008; Pivo & Fisher, 2010). In general, value premiums are higher for LEED (voluntary environmental building code) than Energy Star (single attribute measured building performance audit). Outside North America, studies finding value premiums for green labelled office space have been conducted in the United Kingdom (Chegut, Eichholtz, & Kok, 2014; Fuerst & McAllister, 2011b), the Netherlands (Kok & Jennen, 2012) and Australia (Newell, MacFarlane, & Walker, 2014).

However, deeper research into office markets indicates it is not clear that enhanced asset value results from occupiers of certified space paying higher rent. When the scale of data analysed shifts from the building scale to the tenancy scale, rental price premiums disappear or causality becomes impossible to disentangle with other building attributes. Gabe and Rehm (2014) find no rent premiums from NABERS Energy ratings when modelling office rental contracts in Sydney, Australia. Fuerst, van de

Wetering, and Wyatt (2013) find the rent premium for a labelled building in the United Kingdom difficult to disentangle from the rent premium for a new building.

Outside of commercial office markets, Freybote, Sun, and Yang (2015) finds that LEED for Neighbourhood Development certification does not offer additional premiums beyond those observed for certified housing units within the certified neighbourhood. Robinson, Singh, and Das (2016) found mixed results in regards to the financial performance of LEED labelled hotels. Sale price premiums for certified homes have also been reported using European Energy Performance Certificates (Fuerst, McAllister, Nanda, & Wyatt, 2015) and an aggregation of various green ratings in California (Kahn & Kok, 2014). Measured building performance auditing is not widely used outside the office sector, so these non-office studies involve voluntary environmental building code certifications. Human health-only certification schemes such as the WELL Building label are too new to the market for robust research into their impact on financial value.

To summarise, while most research finds support for the claim that the presence of an eco-label such as a voluntary environmental building code or measured building performance audit leads to higher capital values, there is an ongoing academic debate on the exact source of that value. Furthermore, awareness of the heterogeneity associated with many eco-labels, especially those using the voluntary environmental building code methodology, leads to a more accurate conclusion that these studies measure the marketing value of the label, not necessarily the specific actions involved in acquiring the label. Of course, this would not matter if there was a strong correlation between the presence of a label and resulting environmental or human health outcomes. But as the next section describes, that is not a widely accepted conclusion.

5.3 Environmental Returns to Design- and As-Built-Stage Labelling

The environmental performance outcomes of voluntary environmental building code-certified green buildings have been mixed, but most research concludes that certified buildings do not perform to their full potential. Empirical data on energy consumption is a common metric used to examine the performance of labelled buildings objectively, since energy efficiency is a central component of voluntary environmental building codes (Newsham, Mancini, & Birt, 2009). All voluntary environmental building codes require projects to simulate anticipated energy consumption, usually to some optimal use pattern and often excluding non-core building services. The typical research approach used to compare potential energy performance with measured energy performance is to amend the simulated potential to reflect a whole building consumption estimate.

From a self-selected distribution of 121 of the first 552 LEED certified buildings, Turner and Frankel (2008) examined post-occupancy energy consumption data relative to simulated expectations. On average, the set of 121 buildings met expectations of around 25% reduced energy consumption relative to a regulatory minimum, but the distribution was highly scattered; over half of the projects deviated more than 25% from this mean, including some resulting performance outcomes that would not be deemed compliant with the regulatory minimum. Therefore, at the individual building scale, the outcome of an early-stage green building certificate on building operations can be highly variable, even when the heterogeneity of voluntary environmental building codes are removed by constructing fair comparisons between potential and actual performance.

Further studies attempt to remove the self-selection sample bias associated with Turner and Frankel (2008). These later studies conclude that there is systematic underperformance as a group rather than actual equalling potential on average. For example, Oates and Sullivan (2012) studied 19 office buildings in Arizona, finding that 18 underperformed relative to their LEED rating while, surprisingly, 15 of those 18 failed to meet the baseline building code specification for energy efficiency. Their small sample size and unique arid climate into consideration could lead to a regional sample bias if extrapolating this result to a wider asset population outside the sampling frame. However, similar bias towards underperformance in small samples has been observed in the United Kingdom (Bordass, Leaman, & Ruyssevelt, 2001) and New Zealand (Gabe, 2008). The latter study identifies potential causes as the tendency to specify complex building systems in green buildings that are innovative but challenging to simulate during design and manage during operation.

With the introduction of Green Star Performance, we identify an opportunity to take a census of certifications across multiple building life stages. Descriptive data from Green Star certification data provides further evidence that performance in-use is more average than performance potential indicates. Figure 6.2 is a series of three histograms counting the number of Green Star Australia certifications by certification type and star

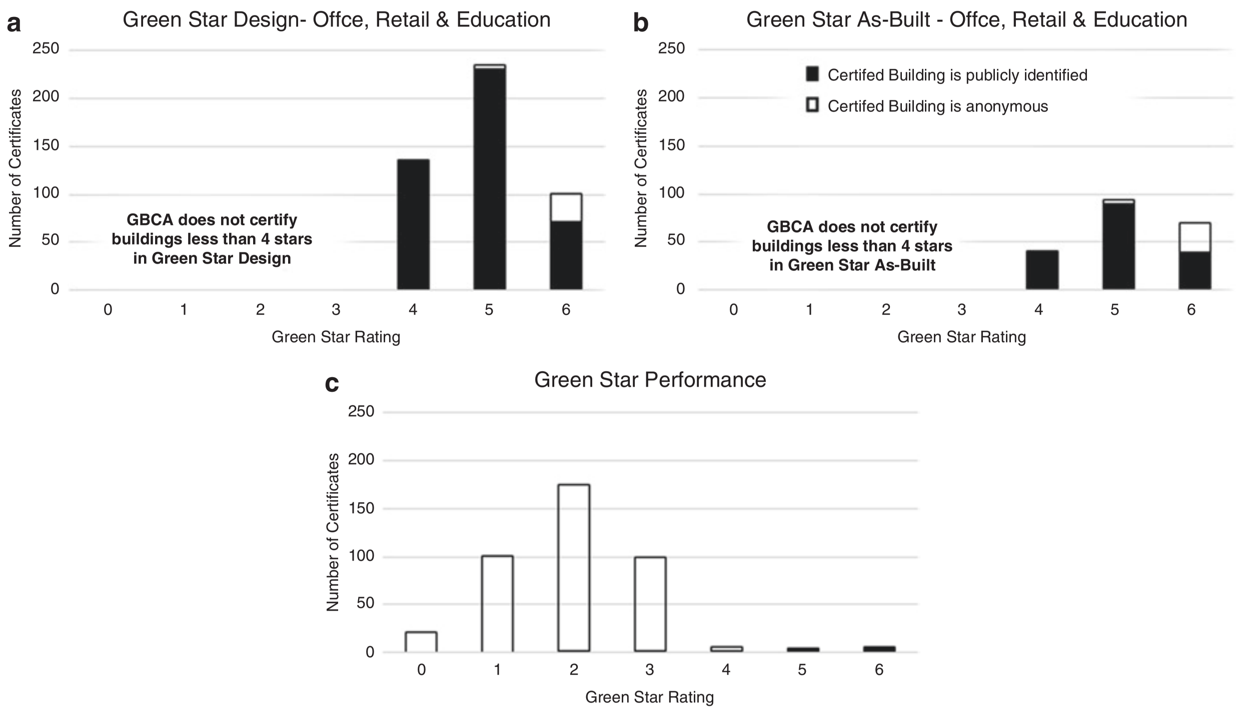

Fig. 6.2 Histogram of the number of buildings certified in Australia by (**a**) Green Star Design, (**b**) Green Star As-Built, and (**c**) Green Star Performance. Note: Design and As-Built counts include the three most popular building typologies (office, retail centre, and educational building) while Performance does not separate buildings by use type. Based on data from the Green Building Council of Australia

rating in the most popular building types (office, retail, and education) from the founding of Green Star to early 2017. The GBCA offers building owners the choice to make identifying characteristics of a labelled building publicly available on the GBCA database (dark shading in Fig. 6.2) or to withhold identifying information from the GBCA database (outline shading in Fig. 6.2). Looking at the histograms in Fig. 6.2 with the caveat that this is not a true panel data set,[18] it appears that buildings perform best on paper during the design and as-built phase, though there is a large drop in the number of buildings that pursue as-built certification as a complement to design certification. However, the more interesting aspect of Fig. 6.2 is the noticeable drop in star ratings when measured in-use. Only a very small fraction of Green Star Performance certifications meet the traditional certification threshold of 4 stars and nearly all of them (95%) choose to remain anonymous behind ratings that would be perceived as poor, even though 1 star or higher represents improvement above the benchmark standard.

In response to a growing consensus that voluntary environmental building code-certified buildings tend to underperform their on-paper potential, the USGBC has taken the opportunity with the latest revision of LEED BD+C (v4, 2016) to better understand why this is the case. As introduced earlier, one of the mandatory requirements of certification under Version 4 of LEED BD+C is to share performance data in-use with the USGBC. While this data is unlikely to be made public, nor will it affect the past award of a LEED BD+C certificate, it will enable the certification agency to better understand causes of systemic underperformance and the risks involved with a life-cycle model of building certification.

5.4 Early Outcomes from Repetitive Measured Building Performance Auditing

One potential cause of the systemic underperformance of buildings certified using voluntary environmental building codes may be the lack of an

[18] Meaning certification activity for the same sample of buildings is not observed at each phase in the building life-cycle. With the near-universal decision to make Green Star Performance certifications anonymous, we cannot construct a sub-sample of histograms that feature the same buildings through their lifecycle. However, we can conclude that, except for an unknown fraction of the design-certified cohort that was never built or has not yet finished construction, each building owner has the opportunity to certify using all three systems.

established framework for ongoing performance assessment. Studies of NABERS Energy, one of the few measured building performance auditing labels that has been around long enough to produce repetitive certification data for research, reveal that repetitive audit participation leads to rapid reductions in measured energy use. By tracking 14 years of NABERS Energy/ABGR disclosures, Gabe (2016a) constructs a sequential series of raw site energy use intensity measurements from over 800 buildings in Australia that have certified more than once. As seen in Fig. 6.3, repetitive certification is associated with both a reduction in the variance between buildings and a statistically significant reduction in the average site energy use intensity. Expectation of a future audit is also important; long time periods between re-certification events lead to statistically significant increases in energy use intensity. In aggregate, the average building undergoing repetitive NABERS Energy audits reduces energy use intensity by 20–30% from the initial audit. A tangential study (Gabe, 2016b) found

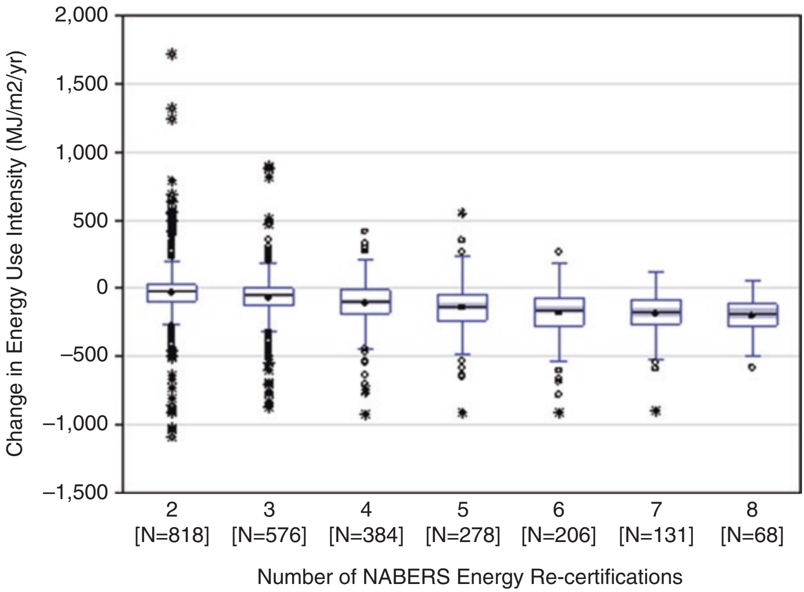

Fig. 6.3 The distribution of change in EUI between first NABERS Energy audit and each subsequent audit (re-certification). Based on data from Gabe (2016a)

that the mechanism of entry (voluntarily or via mandate) had no influence on these outcomes.

Further research on the non-financial outcomes of repetitive labelling activity is likely to increase over the next decade. The accounting framework behind Energy Star has enabled local and state policymakers across the United States to implement mandatory disclosure laws, which rapidly increases the data available for assessing measured performance (Kontokosta, 2013). Multiple attribute labelling systems have a longer time between audits, usually five years, but over the next decade, data on repeat certifications from LEED O+M may be rich enough to evaluate early empirical outcomes associated with a broader scope of measured building performance auditing. In Europe, Bruhns et al. (2011) describe a database of Display Energy Certificates in the United Kingdom, but do not investigate the effects of repetitive audits. The mandatory EPC labelling scheme is an environmental building code framework, but it has a ten-year expiration. Many of the earliest adopting member states have recently reached their second decade of the mandate in the residential property context. Future research on repetitive EPC labelling outcomes will provide an interesting look into how expectations of future labelling assessment affect building design potential.

6 Recommendations

Moving forward, what can be learnt from our review to improve the market for private green building labelling and better integrate sustainability considerations into market transactions? We discuss four recommendations that will improve effectiveness, increase adoption, harmonise benchmarking, and integrate design with operation. There is a general theme in these proposals: the need for a building life-cycle approach to labelling involving design forecasts and operational audits. Standing in the way of this future is the private-sector's hesitancy to introduce downside risk that follow-up disclosed audit information may be perceived negatively. Our review finds market perception matters more than proof of performance when it comes to the financial rewards associated with labelled buildings. Thus, we see a critical role for the public-sector to drive this integration using the tool of mandatory disclosure.

6.1 Improving the Effectiveness of Green Labelling and Reporting Tools

In our review, we find two contrasting narratives on "effectiveness". The first is a positive story on the financial effectiveness of labelling; many empirical studies have demonstrated that the label itself has marketing value. While researchers continue to question the source of that marketing value, there is no support for a claim that obtaining a building eco-label negatively affects the market value of a building. Thus, we find no grounds on which to recommend improvements in the financial effectiveness of green building labelling.

The second narrative on the environmental effectiveness of green labelling is less palatable and signals opportunity for improvement. Empirical evidence on measured environmental outcomes from voluntary environmental building codes largely finds a building stock that performs below its operational design potential. Researchers and labelling firms continue to investigate the causes of underperformance. Encouragingly, early evidence from measured building performance auditing labels reverses this narrative; ongoing re-certification leads to observable environmental performance improvements.

Improving environmental effectiveness is important because a mismatch between marketing messages and in-use performance creates a significant credibility risk for the labelling firms, whose business capital rests on their credibility and independence. Misleading information on the current performance of a building enhances, instead of removes, the information asymmetry market failure that provides an economic rationale for the existence of labelling tools.

Understandably unpopular in a market that values perception over performance, dynamic eco-labels are needed to reflect information appropriate to the current stage of the building's life-cycle. During the design phase, it is sensible for a design team to use Green Star Design, for example, to market a building to construction contractors and potential users. After construction, there is a "settling in" period with insufficient data for a performance audit. However, transitioning to a Green Star As-Built rating for marketing to prospective owners, users, and property managers makes use of the most relevant information available. Lastly, once the building is in use for sufficient time to measure performance, marketing needs to use Green Star Performance to communicate with prospective users and buyers. One can even take this concept further to advocate real-time operational performance management where possible. For example, the USGBC are currently trialling a "LEED Dynamic Plaque" labelling interface wherein real-time operational data is used to create a visual display of the building's current performance across five categories of measurement (energy, water, waste, transportation, and human experience).

Our recommendation for marketing to match the phase of the building life-cycle introduces two important incentives into the property market. First, integration provides the expectation of future auditing, which, importantly, places costs on decisions during construction or operation that may affect environmental or health potential later on in the building's life-cycle. Research has shown expectations of future building performance audits to be effective at maintaining and enhancing performance in use (Gabe, 2016a). Second, our recommendation improves communication, and perhaps legal contracting, between designers and users; knowing that future occupants will need to operate efficiently means designers must consider usability in design.

Dynamic labelling faces an important challenge. It introduces an element of downside risk into the market for green labelling. With private green labelling tools being voluntary, there is only upside risk. Should a building not achieve the goals its designers set, the designers can simply choose not to certify (or remain anonymous), a neutral outcome. If successful, the building gains a label that has improved its marketing value, a positive outcome. The possibility of a negative outcome in dynamic labelling—declining ratings or the loss of a label, for example—is likely to deter voluntary participation, which has two effects. One is that with performance and perception aligned, buildings that excel in this system should be appropriately recognised with higher financial returns. But the other is a result of reduced demand for certification; a private firm in the business of certification may not remain profitable. Therefore, our recommendation implies that research into adoption rates may become more important.

6.2 Increasing Adoption and Use of Voluntary Ratings in Regulation

Besides acknowledgement of rapid adoption rates early in the market for voluntary green building codes (Fuerst, 2009; Kok et al., 2011), researchers are only just beginning to explore adoption rates empirically. Unsurprisingly, regulatory pressures—either the threat of or legislation of mandatory disclosure—are the primary determinants of adoption rates once the novelty of green labelling wears off (Fuerst, Kontokosta, & McAllister, 2014; Gabe, 2016b). Other studies support the environment-as-luxury-good narrative, indicating adoption rates are positively associated with income and market conditions (Kok et al., 2011; Sanderford, McCoy, & Keefe, 2017).

Redistributing or growing income and intervening in real estate markets in the service of increasing voluntary green labelling tool adoption is unlikely. We therefore anticipate that mandatory disclosure policies (Kontokosta, 2013) will be the primary means of targeting increased adoption.

Through research on Australia's mandatory energy performance disclosure regime for commercial office buildings (Gabe, 2016b), we can elaborate on two context factors that have made mandatory energy disclosure successful in Australia. First, single attribute measured building performance auditing tools are the best fit for mandatory disclosure. The cost of compliance—auditing site utility bills, for example—is very low, particularly in the case of repeat audits. Without needing to weight non-comparable credits, single attribute systems provide fair and comparable accounting frameworks and benchmarks for measured building performance auditing. Labelling thresholds and credit weightings within hybrid rating systems (e.g. LEED O+M, Green Star Performance) are typically random round numbers.

Second, Australian success is partially attributed to NABERS Energy being a voluntary labelling tool for a decade before it became mandatory in commercial office building transaction advertisements. For policymakers, this is an important context that enables a three-step process observed in Australia to be adopted elsewhere. First, a group of private asset owners saw sufficient value in differentiation to enable significant uptake of a voluntary disclosure scheme. Second, a market for building retrofits emerged to improve ratings for these pioneering owners. Third, a mandatory disclosure regime provided the incentive for disinterested owners to engage in improving performance at a much faster rate given the presence of the market for building retrofits.

6.3 Harmonising Benchmarking

While we have argued that understanding of green building labelling tools can be simplified into two key genres—voluntary environmental building codes and measured building performance auditing—potential remains for continued market confusion. One example is how certification thresholds are not comparable. For example, a "Pass" in BREEAM involves meeting 30% of applicable credits while the equivalent "Certified" level in LEED involves meeting 40% of all possible credits, and the credits in each are not identical. The most confusing example of disharmony is the use of a 0 to 6 star scale by both Green Star and NABERS in Australia. It appears as if there is harmony in measurement, but Green Stars are based on an ambiguous collection of voluntary environmental building code standards while NABERS stars are based on measured single attribute performance relative to consumption benchmarks from a 1999 benchmarking survey. NABERS and Green Star Australia "stars" are not comparable at all despite sharing the same marketing label. A similar story can be told for the relationship between Energy Performance Certificates and Display Energy Certificates in the United Kingdom. Both use an A to G letter grading system as the label to communicate potential (EPC) or measured (DEC) building energy efficiency, but the EPC is not a forecast of a DEC because the letter grades have a different methodology and different benchmarking thresholds. Furthermore, voluntary environmental building codes and multiple attribute auditing schemes face the challenge of weighting the relative value of compliance with optional building standards that make up scheme credits/points. Some, like LEED, weight credits implicitly while others, notably BREEAM and Green Star, have both implicit and explicit weightings.

We suggest harmonising design- and construction-stage labelling with the accounting benchmarks developed by measured building performance auditing labels is a sensible, but challenging, opportunity to address the confusion. Design- and construction-stage use of these accounting frameworks then become "forecasts" of performance to be directly compared with subsequent performance audits. The survey-based percentile labelling thresholds used by Energy Star, NABERS, and the United Kingdom DEC become rational grounds for meaningful comparisons within a local or national market. Finally, with a design rating directly comparable to an in-use rating, the dynamic labelling process recommended here would ensure harmony across all stages of the building life-cycle. This will work for both single and multiple attribute auditing frameworks, though the latter face an additional challenge in harmonising the inter-credit weighting used to arrive at a single label.

Currently, this is not how voluntary environmental building code credits that could be comparable, such as those for operational energy consumption, are written. BREEAM, LEED, and Green Star reward potential, not actual, consumption targets in these credits. By assuming static use patterns and climate models, designers maximising potential have an incentive to optimise their design to this static use pattern. Our recommendation would require those designers to simulate their design against a range of plausible use patterns to arrive at an expected value of consumption given the resulting probability distribution of simulated outcomes. This changes the incentive of the designer from optimising the building in a particular scenario to optimising the resilience of the design to changes in use patterns.

A further need is to address the heterogeneity that exists in voluntary environmental building code labelling. This can occur in many ways. One is to have an organisation such as the World Green Building Council collaborate with its global network of green building certification firms to agree on performance-based accounting frameworks and survey percentiles that could apply to any market. Another opportunity is to increase disclosure of raw data behind each rating, enabling consultants to provide translation services across markets.

Should markets harmonise labelling via operational auditing frameworks for a range of sustainable building attributes, the next challenge will involve regularly updating the benchmark survey. If a market is becoming more environmentally efficient, a benchmark update will lower, or possibly disqualify, marketing labels specific to a particular building. The literature on the financial rewards from green building studies only the labelling value; until research can better inform markets about the value of measured environmental performance outcomes, marketing perceptions are arguably more important to the market than the activities required to obtain the label. Furthermore, legal frameworks based on labels mean an old benchmarking survey becomes implicitly entrenched in the market. For example, it is common for government agencies to set label minimums for government accommodation; most Australian government agencies state that they prefer tenancies in buildings with at least 4 NABERS Energy stars. Such soft regulation has likely helped inflate the current NABERS Energy population to an average of 4.2 stars. However, the accounting framework is designed such that the average building in the benchmark survey is to be awarded 2.5 stars. With no updates since 1999, such “ratings creep” is unsurprising, but an update would mean a 4-star building becomes 2 or 2.5 stars and, thus fall afoul of government tenancy preferences.

Updates of voluntary environmental building codes face a similar legal disincentive to increase the stringency of credit requirements over time. Since design or as-built Green Star, BREEAM, or LEED labels do not have an expiration date, buildings that certified under the older, less stringent, versions of the voluntary building codes could obtain valuable government leasing agreements instead of potentially better performing, but less distinctively labelled, newly certified buildings. To complement the challenge of progressing benchmarks in both labelling frameworks, we anticipate a challenge for policymakers to keep their public procurement policies up to date and relevant within a rapidly changing industry.

6.4 *Integrating Design and Operation*

We are certainly not the first to collect or present evidence of the need to align incentives between building designers and users.[19] Others have written of the need to overcome an institutional divide where designers' contractual involvement ends with the commissioning of a new building, resulting in no incentive to learn from the user experience (Way & Bordass, 2007). The development of voluntary environmental building codes reinforces these institutional boundaries; designers prefer to be assessed on potential performance as it removes the cost and limitations of cooperating with property managers. Furthermore, the offering of certification for partial building systems such as LEED Core and Shell, LEED for Commercial Interiors, NABERS Energy Base Building or NABERS Energy Tenancy, demonstrates a willingness to accept institutional boundaries, rather than challenge them by requiring greater multi-disciplinary coordination and cooperation over longer periods of time.

Earlier, we argued that a life-cycle based framework could increase the environmental effectiveness of green building labelling. However, we also acknowledged a further barrier to such a solution: the introduction of downside risk. Private firms offering a life-cycle certification regime will likely find a few elite and well-integrated projects to certify voluntarily but soon find themselves out of business due to competition from certification firms that continue to offer single-stage static labelling. As long as the market continues to value financially the perception (i.e. marketing) value of the label, it appears unlikely for a life-cycle based framework to align the

[19] For example, the same recommendation was the central finding of a multi-year research study nearly 20 years ago in the United Kingdom (Bordass et al., 2001).

incentives of designers and users. Tales of the gap between certified buildings' potential performance and their in-use failure to meet that potential have been known for almost a decade (Oates & Sullivan, 2012; Turner & Frankel, 2008), so we can only assume users are collectively disinterested or inadequately informed.

Trivial private financial benefits of environmental efficiency in operation may be a good reason why users are disinterested. Enhancing the value of the biophysical environment is the production of a "public good", or something available to be enjoyed by all irrespective of whether a particular individual or firm paid for its production. Gabe and Gentry (2013) demonstrate that the private cost savings of natural resource efficiency is very low in comparison to other occupancy-related costs, particularly employee labour and building rent. Interestingly, enhancing the indoor environment to promote human health is not a public good but rather a "club good", or a benefit that can be restricted to those paying rent for space in the building "club". Unsurprisingly, most cost-benefit analyses associated with voluntary environmental building codes (e.g. the well-known Kats, Alevantis, Berman, Mills, & Perlman, 2003, report) rely on labour productivity gains, which can be directly associated with indoor environment design, not energy efficiency (Fisk, 2000). Therefore, it is perhaps unsurprising that the system closest to integration between designers, operators, and users is the emergence of the WELL Building Certification; this health-and-wellness-only framework better aligns with a private accounting of costs and benefits.

While the WELL certification scheme is too young to have produced empirical research on its impact in the market, we have included it within this chapter because its unique design supports the recommendation for an integrated labelling system. Although WELL is targeted primarily at new building design, its hybrid structure, with three-yearly performance verification audits always required to maintain certification, provides an incentive for designers to consider building operations. The challenge that may soon face IWBI will be how to maintain its market leadership should a competitor emerge offering a less integrated health and wellness building certification.

Absent coordination between green building labelling firms or collective demand from users, engendering market interest in conserving the biophysical environment in operation is likely to require public regulation, specifically mandatory disclosure using measured building performance audits. The Australian case study provides an optimistic narrative on how this action feeds back to adjust designers' incentives. Once a NABERS Energy label became mandatory in transaction advertising, the Green Building Council of Australia amended the energy performance credit in Green Star Design & As-Built to include an alternate compliance pathway for a building to allow a NABERS Energy Commitment Agreement to obtain credits for energy-efficient design. These agreements require designers to simulate expected energy efficiency in use as opposed to potential energy efficiency in use, with the modelling result becoming a direct forecast of the building's operational NABERS Energy rating. According to the online NABERS database of Commitment Agreements as of May 2017, 60 of 105 eligible Commitment Agreements have been confirmed with an operational NABERS Energy audit at or above the expected rating. A 57% success rate appears low, but when compared with the apparent systematic disconnect between Green Star Design/As-Built and Green Star Performance, the NABERS Commitment Agreement framework is a significant improvement to the integration of design and operation.

7 Conclusion

Green building labelling has evolved into two dominant forms: voluntary environmental building codes and measured building performance auditing. The former, created for and used by building designers, is a collection of voluntary building standards primarily associated with assessing the potential for a building to preserve the biophysical environment. The latter is accounting frameworks for measuring environmental performance in use. A review of empirical studies into the use of these labelling systems reveals a consensus that the market is willing to pay for labelled buildings, but that buildings certified with voluntary environmental building codes often do not perform to their full potential in use.

In response, we propose that a life-cycle-based labelling system is needed to match the incentives of designers with the needs of building users. Such a system faces barriers within the private-sector because private financial value associated with green buildings is primarily associated with marketing value, not intrinsic environmental performance value. The introduction of mandatory non-financial performance disclosure using measured building performance auditing labels introduces a non-financial accounting framework into the market that can successfully align the incentives of designers and users, opening the pathway for life-cycle building labels.

Appendix: Summary of Rating Schemes Reviewed

Scheme name	*Managing firm*	*Labels (lowest to highest)*	*Location of certified buildings*	*Building typologies*
A. Voluntary environmental building codes				
BREEAM New Construction; BREEAM Refurbishment & Fit-out	BRE Global	Pass, Good, Very Good, Excellent, Outstanding	Global	Any
BREEAM Communities	BRE Global	Pass, Good, Very Good, Excellent, Outstanding	Europe and Africa	Masterplanned neighbourhoods
LEED Building Design and Construction	US Green Building Council	Certified, Silver, Gold, Platinum	Global	Any
LEED Interior Design and Construction	US Green Building Council	Certified, Silver, Gold, Platinum	Global	Offices, Retail, Hotel
LEED for Neighborhood Development	US Green Building Council	Certified, Silver, Gold, Platinum	Global	Masterplanned neighbourhoods
Green Star Design; Green Star In-Use	Green Building Council Australia	4, 5, 6 stars	Australia	Any non-residential building
Green Star New Zealand	New Zealand Green Building Council	4, 5, 6 stars	New Zealand	Any non-residential building
Green Star Communities	Green Building Council Australia	4, 5, 6 stars	Australia	Masterplanned neighbourhoods
Homestar	New Zealand Green Building Council	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	New Zealand	Any residential building
PassivHaus	PassivHaus Institut	Classic, Plus, Premium	Global	Residential, Office
NatHERS	Australian Federal Government	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	Australia	Any residential building
Energy Performance Certificate	All EU member state governments	G, F, E, D, C, B, A	Europe	Primarily residential buildings, but some commercial buildings depending on the member state.

(*continued*)

(continued)

Scheme name	*Managing firm*	*Labels (lowest to highest)*	*Location of certified buildings*	*Building typologies*
B. Measured building performance auditing, single attribute schemes				
Energy Star	US Environmental Protection Agency	75 to 100 by integer	USA and Canada	Commercial and Industrial
Display Energy Certificate	UK Government	G, F, E, D, C, B, A	UK	29 types of commercial buildings
NABERS Energy, Water, Indoor Environment, Waste	NSW State Government	0, 1, 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5, 5.5, 6 stars	Australia	Office, Retail, Hotel
C. Measured building performance auditing, multiple attribute schemes				
BREEAM In-Use	BRE Global	Pass, Good, Very Good, Excellent, Outstanding	Global	Any non-residential building
LEED for Building Operations and Maintenance	US Green Building Council	Certified, Silver, Gold, Platinum	Global	Office, Retail, Education, Hotel, Warehouse
Green Star Performance	Green Building Council Australia	0, 1, 2, 3, 4, 5, 6 stars	Australia	Any non-residential building
D. Health and wellness certifications				
WELL Building Certification	International WELL Building Institute	Silver, Gold, Platinum	Global	Office, Retail, Education, Multifamily Residential

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