Reinventing Green Building: A Call to Action

The major US green building rating system, LEED, isn't growing; the green building revolution has stalled; no easy solutions are in sight. By 2015, LEED had certified *less than one percent* of commercial buildings and homes in the United States during its first 15 years. Annual project registrations and certifications for LEED in the United States are now fewer in number in 2015 than in 2010. It's time for a new green building program that works for "the other 99 percent" and that has significant annual growth.

Figure I.1 compares LEED certifications with the total number of US commercial buildings; it shows that total project certifications at year-end 2015 amounted to *less than one percent of the US nonresidential building stock*. (In the residential sphere, the fraction was considerably less.)[1]

We need a new way to rate buildings for their climate and environmental impacts. As the leading green building organization and largest rating system in the United States as well as the largest in the world, the US Green Building Council and LEED have a special responsibility to engage in self-criticism and continuous improvement.

These concerns are not new, but they have taken on more urgency with the upcoming mandatory switch to a new version of LEED (LEEDv4) in October 2016. With most project teams content in knowing how to navigate through LEED 2009, despite its costs and complexities, LEEDv4 appears to be "a bug looking for a windshield."

That LEED is broken is not news; Randy Udall and Auden Schendler first raised the issue in 2005 with a provocative article,

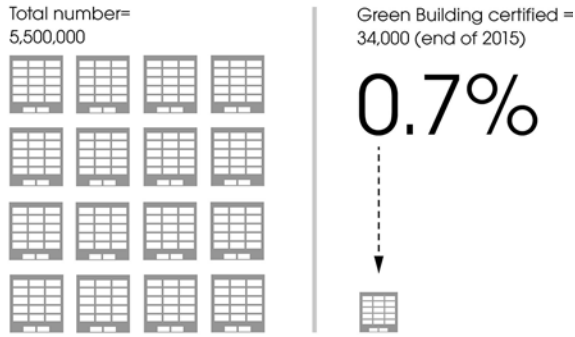

FIGURE I.1. Total US Building Stock vs. LEED Certifications, End of 2015.

"LEED is Broken—Let's Fix It."[2] At the time, many LEED advocates, including me, dismissed issues raised by this article as simply a reflection of growing pains for the LEED system. At the time, LEED was barely five years old and just getting started on the road to dominating the US market for commercial green buildings.

But their five main objections—LEED is too costly, project teams are too focused on gaining points and not on results that matter, LEED's energy modeling is fiendishly difficult, LEED's bureaucracy is crippling and LEED's advocates continually produce overblown benefit claims—remain drawbacks today.

Most experienced green building professionals would also agree that these same issues remain relevant in 2015. But there is a larger problem: Green building rating systems have diverged greatly from building owners' and operators' core concerns, as these systems are designed to meet the needs of green idealists more than those of most market participants.

Green building advocates must abandon the approach they have taken for the past 25 years: comprehensive and overly technical criteria, multiple elaborate rating systems, large and cumbersome bureaucracies, high costs and inadequate focus on real long-term building performance. Instead, they need to embrace the technological revolution that has cut costs for communications by factors of not ten, not one hundred, but a thousand or more in the past 15 years.

Moore's Law, first enunciated in 1965, says that computing power doubles every 18 months; over time, unit costs for computing have fallen in a similar fashion.[3] Consider this: Every six years, it's 16 times cheaper (and faster) to do the same task, every nine years 64 times cheaper! (Every 15 years, it's 16 × 64, or 1,024 times cheaper!) With the advent of mobile communications, social networks, the Internet of Things, Big Data analytics, cloud computing and global information systems, why should green building still be governed by concepts, systems and procedures developed in the 1990s "Dark Ages" of Internet 1.0?

This book's central thesis is that it's time for a serious debate about LEED's (and other systems') inadequacies in addressing a few key issues: combatting global climate change, addressing looming water scarcities and reducing resource waste.

The corollary is that it's time for green building leaders to develop a new model for certifying project design, construction and operations, one that is:

- **Smart:** technology-savvy and mobile-accessible
- **Simple:** so anyone can understand green building standards without specialized training and certification
- **Sustainable:** both in focusing on absolute performance as the best means for addressing climate change, and in accelerating building design and management's movement onto cloud-based platforms.

We don't need to abandon concerns about urban design, healthy buildings, or healthy building materials—but they belong in a separate system or systems. Future green building rating systems should focus ONLY on five Key Performance Indicators:

- Energy use
- Total carbon emissions
- Water use
- Waste minimization
- Ecological purchasing

Until we build most new buildings and retrofit most existing buildings according to dramatically higher standards for energy, carbon, water, waste generation and recycling, then all other considerations are window dressing.

After all, Nature doesn't care how much we *reduce* annual carbon emissions from unsustainably high levels. Nature only cares about *absolute* levels of carbon dioxide (and other greenhouse gases) in the atmosphere, about excessive water use that damages natural ecosystems and about waste that doesn't get recycled into something else.

It turns out that the solution is already staring us in the face: the technological revolution that has given us the mobile Internet, social media and Big Data analytics. With this revolution, we can start with the user's concerns and work toward creating a rating system (or systems) that enhances the user's experience.

How to proceed? Here's an example in one word: Uber.

In 2015, just five years after it started, Uber's latest financing round valued it at $50 billion. What did Uber do? It took on a hundred-year-old urban transportation system—taxicabs—and created an easy-to-use smartphone app that revolutionized it, in the process challenging and upending a highly regulated, low-user-satisfaction industry.[4] No one likes taxis, but if you land at any airport or stand on any street corner in any large city, they're usually the only curb-to-door service available.

What don't we like about taxis? They're not always available when and where you want them; they're hard to get during rush hour, rainstorms and at dinnertime; they are often dirty and uncomfortable; they are prone to occasional customer rip-offs; and they may not accept credit cards for payment. The taxi business's main beneficiaries are taxicab owners, not customers or even drivers.

Uber started with the idea that a ride-for-hire service could address these issues, utilize surplus labor and vehicles, enhance customer experiences and be profitable for all concerned—by using the phone we already carry in our pockets. Brilliant! I've used Uber's smartphone app many times: I can track where the driver is at all times; I know I'm going to get a clean and comfortable car with a

driver who knows the town; and I've already paid the fare and tip when I step into the vehicle.

Uber is so disruptive that it has encountered stiff opposition from everyone profiting from the current system, including "progressive" politicians who are in hock to taxicab owners for campaign contributions, but it will succeed because it's focused on creating a superb user experience. By one account, nearly two million New York City residents have already downloaded the Uber app![5]

Green building certification is ripe for the same disruptive treatment, but it's supremely unlikely that established organizations can or will upend their current revenue models to provide a far more user-friendly approach. It's time for new organizations and fresh thinking in green building. It's time to leave behind the current monastic, hair-shirt experience of LEED certification and create a fabulous user experience. In short, it's (past) time for *Reinventing Green Building*!

PART I

THE GREEN BUILDING MOVEMENT

CHAPTER 1

The Technological Challenge: The Age of Algorithms and Big Data

Once a new technology rolls over you,
if you're not part of the steamroller,
you're part of the road.

Stewart Brand[1]

Prepare yourself for the coming era of ubiquitous and never-ending connectivity. Since the 2001 introduction of the iPod, digital innovations are numerous: the iPhone in 2006, the iPad in 2010, the Apple Watch in 2015, mobile computing's global growth, billions of people on social networks and social media, the advent of the sharing economy, the rise of cloud computing (e.g., via Amazon Web Services, Microsoft Azure and Apple iCloud) and the growing "Internet of Things" (IoT) connecting every imaginable digital device, *all in real time*.

According to Dr. Osman Ahmed at Siemens, four major technologies are "game changers" for anyone in the business of owning or managing buildings:

1. The Internet of Things (IoT), comprising billions of now ubiquitous connected data-gathering devices (an estimated 50 billion interconnected devices by 2020). The IoT is a new market potentially worth $70–$150 billion by 2025.[2]
2. The cloud, which makes computing power available to anyone, anywhere, from any connected device.
3. Mobile devices and open systems, which allow everyone with a smartphone to have access to thousands of apps that help them to manage their life.

4. Big Data analytics, which has the computing power to handle millions of data points from diverse and disparate sources and provide prediction and diagnostics for better managing building operations and energy use, coupled with algorithms guiding use of Big Data.[3]

To this list, we can add widely available cheap sensors that flow building operating data up through the IoT, the cloud and Big Data onto mobile devices. Taken together, these five technologies represent the key trend driving the market for automating building operations (Figure 1.1).

Industry expert Realcomm says that standardized, flexible, secure and state-of-the-art IP networks (both fixed-cable and wireless) make tremendous sense to put in each and every green building, old and new, *right now*, for multiple reasons:[4]

- **Cost**: running many different wiring systems up a building's spine is costly.
- **Adding New Systems**: it's easier and less costly to use a standardized approach.
- **Integration**: without a standard network, getting many different systems to talk with each other is both time-consuming and costly.
- **Support**: supporting the networking/communication needs for many different systems can be difficult and as well as costly.
- **Management Ease**: multiple systems are harder to manage.
- **Security**: securing and managing a single IP network architecture is easier.

In a few years, fully capable building IP networks will become as common as mechanical and electrical systems are today. Quite soon, all equipment that goes into buildings will be IP-ready and based on open systems, making this transition even easier. According to one expert, the IoT model for buildings breaks down into seven functional levels:

> *Devices* are connected and send and receive data interacting with the *Network* where the data is transmitted, normalized

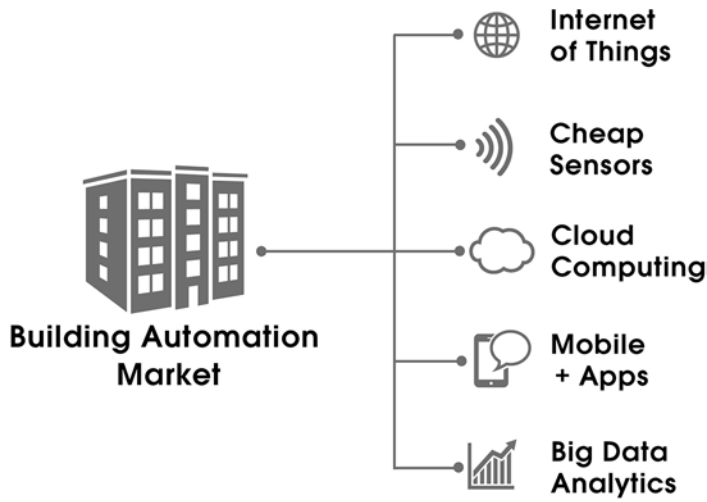

FIGURE 1.1. Five Technologies Driving the Market for Building Automation

> and filtered using *Edge Computing* before landing in *Data storage* and *Databases* accessible by *Applications* which process it and provide it to *People* who will act and collaborate using the data.[5]

Building design, construction and operations are about to undergo seismic shifts, with advanced design software and cloud-based building management systems. Yet during the past 15 years green building certification has hardly changed, except that (in some cases) data for certification can now be extracted from design documents and operational data, and then uploaded to web-based platforms. It is, however, still evaluated item by item by review teams of professional consultants and building assessors.

There are a few exceptions. Paul Shahriari, an experienced software developer for green products, created a decision-making app, *ecomedes*, that allows one to easily calculate the payback from green investments such as water-conserving toilets and fixtures (Figure 1.2).[6]

In 2012, USGBC introduced an app, the Green Building Information Gateway (GBIG) that allows you to find on your smartphone LEED-certified green buildings in any city, using USGBC's project

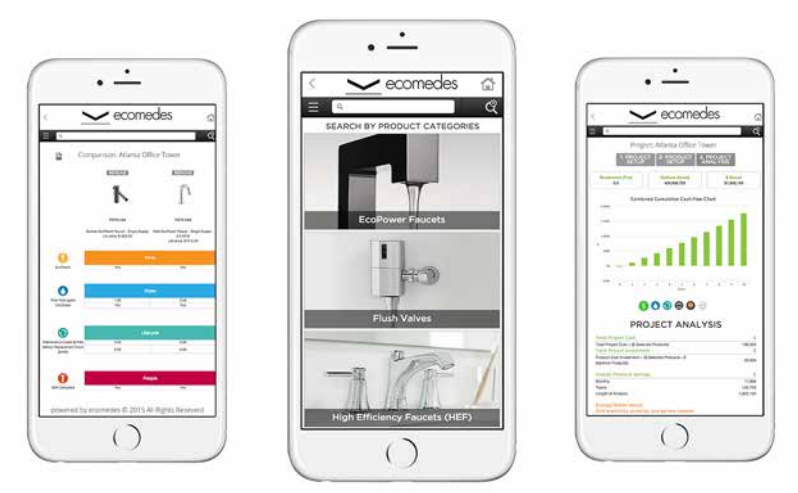

FIGURE 1.2. The *ecomedes* App. Credit: ecomedes, LLC, Paul Shahriari

database.[7] That's just about the extent of the mobile revolution in green building.

Just as mobile and cloud-based technologies have totally disrupted revenues and business models for such technology leaders of the 1990s and 2000s as Intel, Dell, HP, Nokia, Microsoft, Research in Motion, etc., and made Apple the most valuable stock of any company in the world in 2015, isn't it logical to expect that these disruptive technologies will soon challenge and disrupt green building design, construction and operations as well as certification's current analog-based model?

In *The Attacker's Advantage*, management guru Ram Charan writes about the "structural uncertainty" of our times:

> Every day more [people] have instant access to any and all knowledge and insights that exist, as well as the ability to collaborate with others as never before. Their ideas can be scaled up swiftly, because capital is readily available to fund promising ideas. For digital companies, the scaling can be accomplished extremely fast and at low incremental cost. On the other side of the coin, consumers have acquired great new powers because of digitization and online connectivity…that

> give them information and options they never had before.… Every uncertainty is magnified by the quantum increases in the speed of change.[8]

This book's central thesis is that these rapid technological changes present a major challenge to our current approach to green building certification, but also represent significant opportunities for making changes that could greatly expand the market for green building by lowering costs dramatically and engaging both building owners and occupants in reducing energy use. We'll return to this theme often in this book.

The Great Convergence: Real Estate, IT, Energy and Sustainability

Given technology's constant and rapid change, what's happening with the built environment and building operations? How has it responded to digitization and online connectivity? Neglecting for a moment the revolutions in architectural design and building construction, it's easy to see how this revolution is reordering building operations. Figure 1.3 shows this convergence.

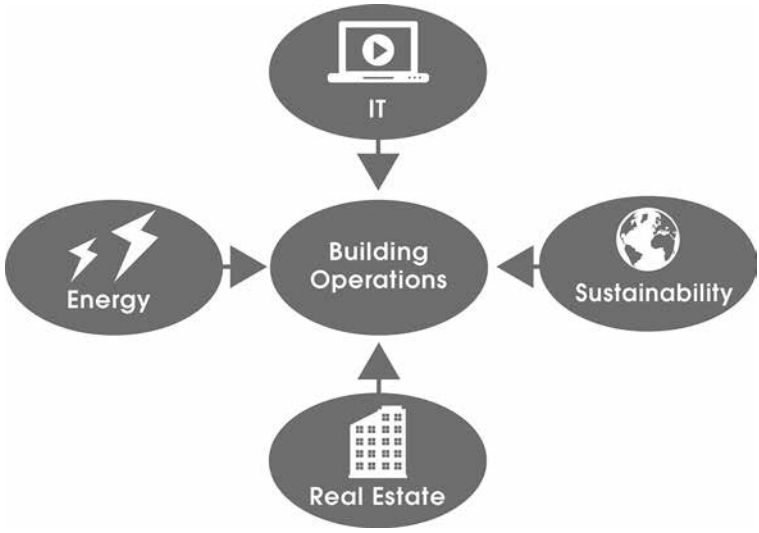

FIGURE 1.3. The Convergence of Real Estate, IT, Energy and Sustainability

Essentially, information technology and real estate have been converging for many years. For example, in large swaths of commercial real estate, most rents are billed and collected online. What's new since about 2011 is that the convergence has added energy and sustainability as key components.

New digital "dashboards" allow near-real-time assessment of a building's electricity use, typically in 15-minute intervals, compared against (an engineer would say "normalized to") any parameters you want: climate zone, local weather, occupancy, building type/use and geographic location; and display that information in many visual formats, readily available on any Internet-connected device to anyone who has access rights. In a building, as shown in Figure C.12 (color plates), one could display for example, daily, weekly and monthly building energy use to tenants or occupants as a way to influence behavior or reward good efforts.

Dashboards and similar cloud-based software can also handle hundreds of buildings simultaneously, allowing portfolio managers and third parties to readily observe and act on information in real time, since electricity use is time-stamped daily and even hourly. Because electricity use (along with monthly gas, diesel, water, etc.) can be easily analyzed, visualized, communicated to anyone who needs to know via SMS (text) message and reported in various formats, it should be easy to assess a building's key sustainability performance variables and to improve them using these new management tools.

Of course, that's good for assessing operations for existing buildings, but what about new construction? Here again, the digital revolution is gaining speed, with Revit and similar BIM (Building Information Modeling) software used for design, from which it should be possible to perform a complete green building assessment with very little user or assessor interaction, knowing building location, design features and product selection.

How hard would it be to write a piece of software that looked at the floor-by-floor layout of a building and determined whether 90 percent of the building occupants had a view of the outdoors or had

adequate lighting levels, and then to connect that information to a green building rating system? Why should anyone be tasked with documenting or assessing such a feature when an algorithm could do it so much easier and faster? Why are the leading green building rating systems not moving to create APIs (Application Program Interfaces) that third parties could use to create these features?

Paul Shahriari started *ecomedes* to address a critical problem, one that many market leaders are ignoring:

> Somebody has to create linkages between component product manufacturers' data and the characteristics of those products as a whole, and then somebody at the automated design platform needs to specify—how many square feet do we need? [But the problem is] with sustainability, since to get more detail out of our projects we are dramatically increasing the amount of work that has to be done by a project team. That is not a good recipe for growing adoption and a market. To me, solving that is one of the first steps, and then all the other stuff can also be done digitally.[9]

The Age of Algorithms

The entire green building assessment process could easily be turned over to algorithms, eliminating a need for third-party auditors or assessors, as well as expensive consultants, essentially allowing projects to "self-certify" and cutting costs by 10 or even 100 times.[10] Every project that met certain criteria could be labeled a "green" building, without engaging consultants, requiring uploads to a website by dozens of hands, review by "experts," and finally, many months (even a year or more) later, receiving a rating at a certain level, as is now the case with LEED certification.

In later chapters, we will explore what this opportunity will require, e.g., eliminating "analog" criteria currently embodied in most green building rating systems and substituting strictly "digital" criteria. But for now, consider why a focus on algorithms and digital assessment is so important.

Ram Charan comments:

> The single greatest instrument of change…is the advancement of mathematical tools called algorithms and their related sophisticated software. Never before has so much mental power been computerized and made available to so many.… In combination with other technological factors, algorithms are dramatically changing both the structure of the global economy and the lifestyles of individual people.[11]

We already know that "flash trading" on Wall Street, done strictly with algorithms, has made it virtually impossible for smaller and short-term investors to gain any advantage.[12] Algorithms are far smarter than any individual, far quicker to apply and far more able to incorporate new information as fast as it becomes available.

Bringing Green Building Certification into the Age of Big Data

With such dramatic changes underway and more on the horizon, why is green building, including its certification protocols, still stuck in the "horse and buggy" stage? As we will demonstrate later, one consequence is that, more and more, building owners are turning their backs on certification and leaving certification's "benefits" on the table, as a reaction to high costs, long certification times and the system's complexity.

The next big problem is trying to assess product "ingredients" on the numerous products specified for a typical building. Try sorting through Environmental Product Declarations (EPDs) and Health Product Declarations (HPDs) by the hundreds (soon to be thousands), without using advanced digital tools, and you will see the colossal waste of time and money embodied in our current approach to assessing building product "greenness," one spec sheet at a time.

Fortunately, new tools keep evolving to meet this challenge. Only cloud-based software can help you make sense of thousands of products and building systems' EPDs using "data sheets" from each individual product, which manufacturers constantly change. Without

using cutting-edge software to automate creating and delivering environmental performance assessments and material health evaluations, in a way that provides understandable and meaningful information, says Sustainable Minds' CEO Terry Swack, there is no real benefit to having the information:

> Today's EPDs can't help make greener purchase decisions—other than enabling a box to be checked [on a LEED form]. There's little to no information in an EPD that an architect, builder, contractor can really use to say, "Hey, this actually is a greener product, I'm going to buy it." Other than industry average EPDs, there are no LCA (Life-Cycle Assessment) product benchmarks, and EPDs for similar products from different manufacturers cannot be compared for a variety of reasons.[13] The only requirement [currently] is to deliver the technical data. There is no requirement to help specifiers figure out how to use it.

According to Swack, manufacturers should build their brands by providing credible and *understandable* environmental information about their products. In this way, they can over time build a greener brand by *demonstrating they know what they're doing.* Users who want to make greener purchase decisions require consistent, understandable and meaningful information.[14]

A Smorgasbord from the Internet of Things

Many technologies on the market today collect information from building operations; analyze it; visualize it; and tell someone what to do about it, how to control it better and communicate it to building occupants. The following examples showcase a few representative technologies that green building advocates should know about and use to change how they approach greening the built environment. These technologies exemplify a revolution that is making everything *Smaller, Faster, Lighter, Denser, Cheaper*[15]—helping us to realize how to create sustainable changes in buildings by taking a ride on the information revolution's bullet train.

Wireless Sensors. In 2011, I gave a talk in Toronto to the EnOcean Alliance, a trade group that develops standards for wireless sensors. In essence, since every building has wireless connectivity (as do most homes) why not have wireless sensors everywhere? They're easy and cheap to install and work via electricity stored in capacitors that capture several forms of ambient energy: photoelectric (from ambient lighting), a phenomenon first explained in 1905 by Albert Einstein; thermoelectric (working on only 2°F temperature differences), a technique that has powered devices for decades; and the piezoelectric effect, where pushing an on-off switch can transfer that energy into electricity via an organic "crystal."

What's the implication? In a hotel for example, every room could be equipped with a key card that would turn off all the HVAC equipment and lights whenever you left the room, saving considerable energy. It could also be controlled from the front desk, so the air-conditioning or heating could be turned on to your desired temperature before you check in. This opportunity is technologically available right now; according to experts, in 30 minutes one can retrofit a hotel room with a key card, using "peel-and-stick" sensors.

Wireless sensors can connect back directly to certification systems, as can sensors in intelligent lighting systems. It's exciting to think about all the data that will soon be at the fingertips of building owners (and cheaply too)!

Cheap Electrical Submeters. Coming to the market soon will be a stick-on electrical submeter, a wireless sensor that attaches directly to an electrical line coming into an electric breaker at a panel, reads electricity use, sends data out wirelessly and powers itself using just line current.[16] You can submeter everything quite cheaply, collect the data wirelessly and analyze it on a Big Data platform, really getting a handle on electricity consumption by end-use. Pretty cool stuff!

Remote Building Audits. Consider again what software and algorithms can do to make data analysis for green building operations

readily accessible and affordable. A company like FirstFuel Software can provide building audits and actionable recommendations for energy efficiency upgrades by combining a building's electricity meter and weather data with third-party data, building information and their own building engineering expertise. Loaded into the company's platform, algorithms can deliver actionable insights for every building. The company then applies its own deep-data frameworks, along with advice from experienced building scientists and engineers, to provide energy conservation recommendations, performance monitoring and alerts, forecasts and energy savings estimates—all tailored to each specific building.[17]

Using algorithms to analyze large amounts of data in the cloud in real-time can help companies and organizations tackle annual energy waste amounting to tens of billions! As an example, working with the US General Services Administration and "analyzing the 4.1 million-sq. ft. Ronald Reagan Building in Washington, DC, FirstFuel found that two large exhaust fans were unnecessarily operating at full speed. Adjusting the fans' set points to their original design levels contributed to the Reagan building saving $800,000 in one year."[18] Overall, GSA audited 180 buildings remotely using building data and the FirstFuel algorithm, and found $13 million in annual savings. This shows software's power to guide users toward energy-saving measures quickly and accurately, without expenses for onsite audits, engineering studies and consultants' reports.

Comfort via Mobile App. Another app called *Comfy* uses a smartphone to allow a building occupant to "dial up" more heating or cooling in whatever space they happen to be in, using either a mobile device or a desktop computer (Figure 1.4).[19] More importantly, the app learns over time what temperature is best at any location in the building. Empty spaces would be conditioned less, saving energy. Key to its value is that user engagement helps to improve productivity and accommodate a workforce that has diverse comfort requirements.[20] And, as a bonus, there may be no more intra-office fighting over the thermostat setting!

FIGURE 1.4. Comfy App Allows Users to Request Exact Temperature for Their Comfort. Credit: Courtesy of Building Robotics, Inc.

Automated Energy Star Reporting. Several building dashboards currently can automatically report energy use data to Energy Star and qualify a building for an Energy Star score and, if it scores in the top quartile of similar buildings, secure recognition as an "Energy Star" building from the US Environmental Protection Agency. (See Chapter 12 for further discussion about Energy Star.) Lucid's BuildingOS platform, shown in Figure 1.5, provides this service for building portfolios.[21] This process also allows easy real-time analysis of a portfolio's performance and lets managers immediately identify poorer performers and make plans to upgrade them.

The future will get even more engaging, as green building pioneer John Picard predicts,

> Imagine that the skin, security, energy, water, controls, mechanical, lighting and occupants of a building are all talking to each other in real time. The buildings are sensate, adaptive, regenerative, cost effective and healthy. It's a reality on the very near horizon…the availability of data will guarantee more green buildings.[22]

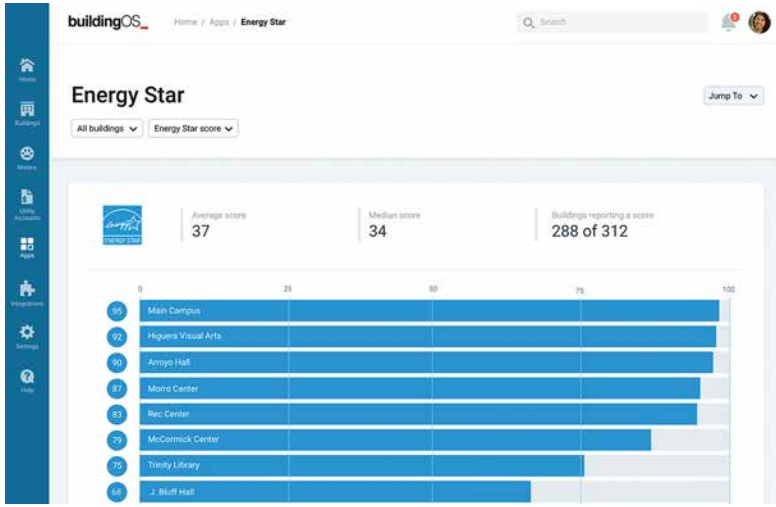

FIGURE 1.5. Automated Energy Star Reporting With Lucid's BuildingOS Platform. Credit: © Lucid

Summary

These are just a few examples of how technological changes, including mobile, wireless, Big Data and cloud-based technologies, along with the age of algorithms, have arrived at the doorstep of building owning and managing. With this much technology already available to manage sustainability in buildings, it's surprising that green building certification does not just piggyback on such platforms to cut costs and dramatically improve user satisfaction.

In the next chapter, we'll look at "Megatrends" in the built environment that are changing how buildings are built, operated and managed to produce green outcomes. These megatrends can become drivers for changes in our current green building certification systems and they help us understand how to "reinvent green building" by using vastly increased capabilities provided by new technology to make everything smaller, faster, lighter, denser and cheaper.