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Chicago Building Code Modernization

Energy Performance and Sustainability Implications

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Council on Tall Buildings and Urban Habitat

Energy Performance and Sustainability Implications

Abstract

In 2017 and 2019, the City of Chicago updated existing laws regulating buildings' energy efficient design, energy performance benchmarking, and environmental sustainability. These changes intend to significantly increase the energy and environmental performance of Chicago's built environment. This will impact project requirements and the design and construction process. This paper reviews the changes between these regulations' updated and previous versions to assist project teams in making informed early-phase design decisions on new-construction and renovation commercial projects.

Keywords: Chicago, Benchmarking, Energy Code, Sustainability

1.0 Introduction

As of June 2019, new construction and building renovation projects must comply with an updated City of Chicago Energy Conservation Code, now based on the 2018 International Energy Conservation code (IECC 2018) (see Figure 1). Shortly afterwards, on 1 August 2019, the Chicago Energy Rating System, updated to reflect the existing Chicago Benchmarking Ordinance, went into effect. Coupled with the 9 January 2017 Chicago Sustainable Development Policy (CSDP), these modernizations are strides towards realizing a more sustainable, lower-emission built environment.

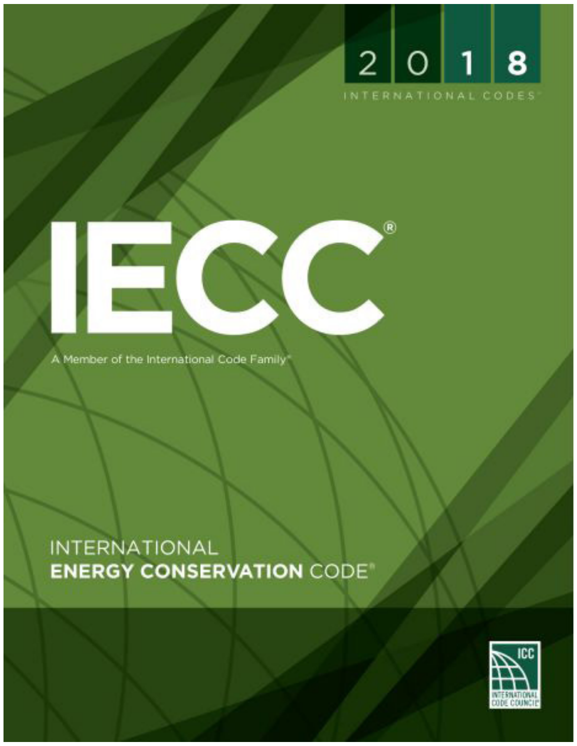

Figure 1. Front cover of the 2018 IECC, the basis for the Chicago Energy Conservation Code applicable for permit applications initiated in Chicago after June 1, 2019. © ICC

However, the rapidly changing regulatory landscape concerning building energy conservation and green construction has significantly disrupted "business as usual" for planned developments and major renovations of commercial buildings. Code compliance documentation is approaching the complexity of a third-party sustainability certification documentation. Building owners and project teams face an array of new, interrelated requirements that, if misunderstood and misapplied, could result in permit review comments and change orders, causing project delays and budget overruns.

Owners and project teams can likewise anticipate a smoother permit approval and project-delivery process if they develop a clearly-defined compliance strategy as part of the conceptual design process, and periodically review the design for continued compliance with the budget and goals defined at project outset.

The following sections summarize the significant updates to the Chicago Energy Conservation Code, Sustainable Development Policy, and Benchmarking Ordinance, relevant to developing a compliance strategy.

2.0 2019 Chicago Energy Code Update

City of Chicago Department of Buildings states: "For permit applications started on or after June 1, 2019, the Chicago Energy Conservation Code (Title 14N of the Municipal Code), based on the 2018 edition of the International Energy Conservation Code [2018 IECC], applies" (City of Chicago 2019). The previous energy code was based on the 2015 IECC. The City adopts the State of Illinois Energy Code (with amendments), which in turn updates (with review and state approval) on a three-year cycle to track the three-year IECC update cycle (SEDAC 2019). The next update to the Chicago Energy Conservation Code in 2022 will apply the as-yet unpublished 2021 IECC as its basis.

The 2018 IECC code format does not markedly vary from the 2015 edition, and preserves the same chapter order. It covers all buildings except historic buildings, or buildings that use neither electricity nor fossil fuels for space conditioning. As before, the commercial provisions (the subject of this document) apply to all covered buildings over three stories, regardless of height or program, while the residential provisions (beyond the scope of this document) apply to residential buildings three stories or lower.

There are still three primary compliance paths in the 2018 IECC: *prescriptive, component performance alternative, and performance* (IECC 2015, 2018). The *prescriptive* path is the simplest to document, and requires projects to comply with both mandatory and prescriptive portions of the code specifying minimum envelope and MEP system performance, and is only available to projects with less than a 40 percent window-to-wall ratio. Projects with window-to-wall ratios larger than 40 percent may comply via the *component performance alternative* (commonly called "envelope trade-off") path. This requires that the project's envelope (including glazing and foundation) have an area-weighted U-value less than or equal to that of a code baseline building with identical geometry, but with code-minimum insulation and a 40 percent window-to-wall ratio. MEP systems still must comply with mandatory and prescriptive requirements. The *performance* path only enforces the mandatory portions of the code. This allows the project team to trade between envelope- and MEP-performance-guided paths, documented by integrating energy modeling into the design process and comparing the proposed design's predicted annual energy cost to a corresponding code-baseline building's equivalent predicted annual energy cost.

Commercial projects can also elect to comply fully with the provisions of ASHRAE 90.1-2016, similarly to the 90.1-2013 alternative offered by the 2015 IECC. The 2018 IECC and 90.1-2016 have similar requirements, with some exceptions (particularly in the energy model-based performance path); a detailed comparison is beyond the scope of this paper and is best discussed on a project-by-project basis with an energy code-compliance consultant.

While a detailed analysis from the Pacific Northwest National Lab (PNNL) is still pending, the Department of Energy estimates that the 2018 IECC represents a 2-to-5-percent net gain in efficiency over the 2015 IECC (Nevada Governor's Office of Energy 2018). These efficiency gains are due to the following changes that improve energy performance (MEEA 2018):

- *Airspace Thermal Performance Stipulations*
  Section 402.2.7 requires that all airspaces included in assembly thermal performance calculations be enclosed in an unvented cavity that minimizes entering and leaving airflow. Vented cavities and any surfaces outboard thereof may not be considered in assembly thermal calculations.

- *Glazing SHGC Reduction*
  Section C402.4 requires that projects pursuing the prescriptive or component performance alternative paths have glazing solar heat-gain coefficients (SHGC) less than SHGC-0.38 on south, east, and west façades, and less than SHGC-0.51 on north façades. This is a reduction of 0.02 from 2015 IECC values, meaning that previously code-compliant glazing selections may be now be non-compliant for new projects.

- *Showerhead Flow Rate*
  Section C404.9 requires that all showerheads in all buildings shall not exceed 2.0 GPM (7.6 l/min) at 80 psi (552 kPa); these fixtures were not previously directly regulated. This regulation can be satisfied by specifying EPA WaterSense-labeled fixtures (EPA 2017).

- *Heated Slab Insulation*
  Section 402.1.3 requires R-5 insulation underneath all heated slabs in all buildings in addition to 24 inches (610 millimeters) of vertical R-15 perimeter insulation, whereas previously only the vertical perimeter insulation was required.

- *Garage Door Thermal Performance*
  Section 402.1.4 requires garage doors with less than 14 percent glazed area be specified at a thermal performance at or lower than U-0.31.

- *Lighting Power Allowance Reduction*
  Section C405.3.2 now mandates lower allowable maximum lighting power densities across all types of buildings and spaces—by as much as 70 percent lower than 2015 IECC levels, depending on building or space type (see Table 1).

Building Type	2015 IECC LPD [W/SF]	2018 IECC LPD [W/SF]	2015–2018 Reduction
Office	0.82	0.79	-3.6%
Hotel	0.87	0.75	-13.8%
Retail	1.26	1.06	-15.8%
Convention Center	1.01	0.76	-24.8%

Table 1. IECC Maximum Allowable Interior Lighting Power thresholds, from 2018 and 2015 IECC Table C405.4.2(1) Interior Lighting Power Allowances: Building Area Method, which specifies maximum lighting power density on a whole-building and predominant-program basis. Source: ICC 2015, 2018

- *Open Office Occupancy Sensors*
  Section 405.2.1.3 requires that all lighting in open-plan offices shall be divided into control zones less than 600 square feet (55.7 square meters) each, with each zone equipped with occupancy controls that turn off the lights 20 minutes after the last occupant leaves and override any daylighting controls present. Previously, no occupancy controls were required in open offices.

- *Renewable Energy Cost Offset Cap*
  Section C407.3 now caps the utility cost offset due to on-site renewable energy that project teams can take credit for when using the energy model-based performance path to 5 percent. Any excess production over 5 percent of annual building energy consumption cannot be used to offset for credit when comparing against the baseline, as was previously allowed.

In addition to the performance requirements, the 2018 IECC incorporates the following editorial changes (City of Chicago 2017):

- Adds clarifying language to the air barrier definition
- Adds clarifying language to the air barrier construction section
- Adds definition for cavity insulation
- Revises definitions for skylights and vertical fenestration
- Creates two new sections for below-grade wall insulation and opaque doors
- Reorganizes daylight zone requirements and clarifies requirements for top-lit zones
- Clarifies language in section C402.5.3, Rooms Containing Fuel-Burning Appliances

The code also revises the definition of "approved" from "Approval by the code official as a result of investigation and tests conducted by him or her, or by reason of accepted principles or tests by nationally recognized organizations" to "acceptable to the code official" (ibid.). This grants the code official broader freedom to determine what means and methods they deem approved.

3.0 2017 Chicago Sustainable Development Policy Update

The City of Chicago first implemented the Chicago Sustainable Development Policy (CSDP) in June 2004, which required development projects receiving financial assistance or special city approvals to include sustainable elements. The City of Chicago Department of Planning and Development (DPD) states that as of 2013, the program contributed to more than 500 new green roofs, totaling nearly 5.6 million square feet (520,257 square meters) and more than 500 LEED-certified projects, totaling about 180 million square feet (16.7 million square meters) (City of Chicago Office of the Mayor 2013).

The City of Chicago convened an advisory committee and updated the CSDP in 2016 after extensive public input. All planned development (PD), Tax Increment Financing (TIF)-funded, and Department of Planning and Development Multifamily (DPD-MF) projects, both new construction and renovations, applying for permits after 9 January 2017 must comply with the updated CSDP (City of Chicago 2017).

The updated CSDP includes a menu (see Figure 2) of sustainable design strategies divided into 10 categories (City of Chicago Office of the Mayor 2013):

1. Health
2. Energy
3. Stormwater
4. Landscapes
5. Green Roofs
6. Water
7. Transportation
8. Solid Waste
9. Workforce
10. Wildlife

Compliance Options	Points Required		Sustainable Strategies Menu													
			Health	Energy							Stormwater					
					Choose one				Choose one		Choose one					
Compliance Paths	Starting Points	Number of Optional Points Required New Construction / Substantial Rehab / Moderate Rehab	1.1 Achieve WELL Building Standard	2.1 Designed to earn the Energy Star	2.2 Exceed Energy Code (5%)	2.3 Exeed Energy Code (10%)	2.4 Exeed Energy Code (25%)	2.5 Exeed Energy Code (40%)	2.6 Onsite Renewable Energy (3%)	2.7 Onsite Renewable Energy (5%)	3.1 Exceed Stormwater Ordinance by 25%	3.2 Exceed Stormwater Ordinance by 50%	3.3 100% Stormwater Infiltration	3.4 Sump Pump Capture & Reuse	3.5 100-year detention for lot-to-lot buildings	3.6 100-year Detention for Bypass
Options Without Certification																
All Options Available	0	100 / 50 / 25	40	30	20	30	40	50	10	20	10	20	40	5	5	5
Options With Certification																
LEED Platinum	95	5 / 0 / 0	40	NA	NA	NA	NA	NA	NA	NA	10	20	40	5	5	5
LEED Gold	90	10 / 0 / 0	40	NA	NA	NA	NA	50	10	20	10	20	40	5	5	5
LEED Silver	80	20 / 0 / 0	40	NA	NA	NA	40	50	10	20	10	20	40	5	5	5
Green Globes 4-Globes	90	10 / 0 / 0	40	NA	NA	NA	NA	50	10	20	10	20	40	5	5	5
Green Globes 3-Globes	80	20 / 0 / 0	40	NA	NA	NA	40	50	10	20	10	20	40	5	5	5
Green Globes 2-Globes	70	30 / 0 / 0	40	NA	NA	NA	40	50	10	20	10	20	40	5	5	5
Living Building Challenge	100	0 / 0 / 0	40	NA	NA	NA	NA	NA	NA	NA	10	20	40	5	5	5
Living Building Challenge Petal	90	10 / 0 / 0	40	NA	20	30	40	50	NA	NA	10	20	40	5	5	5
Enterprise Green Communities*	80	20 / 0 / 0	40	NA	NA	NA	NA	NA	10	20	10	20	40	5	5	5
PassiveHouse	70	30 / 0 / 0	40	NA	NA	NA	NA	NA	10	20	10	20	40	5	5	5

	Landscapes				Green Roofs		Water		Transportation							Solid Waste	Work Force	Wildlife	
					Choose one		Choose one											Choose one	
Compliance Paths	4.1 Working Landscapes	4.2 Natural Landscapes	4.3 Tree Planting	4.4 Achieve Sustainable Sites Certification	5.1 Green Roof 50-100%	5.2 Green Roof 100%	6.1 Indoor Water Use Reduction (25%)	6.2 Indoor Water Use Reduction (40%)	7.1 Proximity to Transit Service	7.2 Bikeshare Sponsorship	7.3 Bike Parking Residential	7.4 Bike Parking Commercial & Industrial	7.5 EV Charging Stations	7.6 EV Charger Readiness	7.7 CTA Digital Displays	8.1 80% Waste Diversion	8.2 Workforce Development	9.1 Bird Protection (Basic)	9.2 Bird Protection (Enhanced)
Options Without Certification																			
All Options Available	5	5	5	20	10	20	10	20	5	5	5	5	10	5	5	10	10	5	10
Options With Certification																			
LEED Platinum	NA	NA	NA	20	10	20	NA	NA	NA	5	NA	NA	NA	5	5	NA	10	5	10
LEED Gold	5	NA	5	20	10	20	NA	NA	NA	5	NA	NA	10	5	5	10	10	5	10
LEED Silver	5	5	5	20	10	20	NA	20	NA	5	NA	NA	10	5	5	10	10	5	10
Green Globes 4-Globes	5	NA	5	20	10	20	NA	NA	NA	5	NA	NA	10	5	5	10	10	5	10
Green Globes 3-Globes	5	NA	5	20	10	20	NA	NA	NA	5	NA	NA	10	5	5	10	10	5	10
Green Globes 2-Globes	5	5	5	20	10	20	NA	20	NA	5	NA	NA	10	5	5	10	10	5	10
Living Building Challenge	NA	NA	NA	20	NA	NA	NA	NA	NA	NA	NA	NA	10	5	NA	NA	10	5	10
Living Building Challenge Petal	5	NA	5	20	10	20	10	20	NA	5	NA	NA	10	5	5	10	10	5	10
Enterprise Green Communities*	5	5	5	20	10	20	10	20	5	5	NA	NA	10	5	5	10	10	5	10
PassiveHouse	5	5	5	20	10	20	10	20	5	5	5	5	10	5	5	10	10	5	10

*only available to affordable housing projects funded by DPD's Housing Bureau

Planned Development Projects (PD) - New Construction	100 points required
TIF Funded Development Projects (TIF) - New Construction*	100 points required
DPD Housing, Multi-family (>5 units) Projects (DPD-H MF) - New Constr	100 points required
PD, TIF, DPD-H MF and Class L - Renovation Projects*	
Moderate Renovation Projects	25 points required
Substantial Renovation Projects	50 points required

*does not apply to TIF assistance of less than $1M (including but not limited to TIF-NIP, TIF Purchase Rehab, Streamlined TIF and SBIF programs)

Moderate Renovation Projects = projects including partial or minor upgrades to building sytems and minor repairs to the exterior envelope
Substantial Renovation Projects = projects including new and/or upgraded building systems and extensive repairs to the exterior envelope

Figure 2. Updated Chicago Sustainable Development Policy menu of sustainable strategies and starting "bonus points" for achieving third-party sustainability certifications. Source: City of Chicago Department of Planning and Development

A web link to the full-size version of the menu is available in the Appendix. Each menu strategy is assigned a point value. For example, under the "Water" category, project teams can achieve 10 points by designing to reduce indoor water usage by 25 percent over code baseline levels or 20 points (not additional) for a 50 percent reduction. New construction PD, TIF, and DPD-MF projects must earn a total of 100 points to comply, while PD, TIF, DPD-MF, and Class L (Landmark) renovations must earn 25 or 50 points depending on the scale of renovation, broadly defined as minor repairs vs. major upgrades. This framework allows project teams to select sustainability measures relevant and feasible for their building and site resources and challenges.

There are two compliance paths to achieving the required points (City of Chicago Office of the Mayor 2013). In the first, project teams simply choose from the menu strategies until meeting the required number of points as described above. In the second path, project teams pursue an approved third-party sustainability certification (such as LEED or Green Globes) to achieve a fixed number of starting points, and then complete the path to the required number of points with available menu strategies. It is important to note that if complying via the third-party certification path, some menu strategies are eliminated as possibilities for closing the gap to the required number of points. This is to avoid granting double credit for pursuing a strategy already required by the third-party certification. For example, project teams seeking 80 starting points by pursuing LEED Silver certification may not take credit for a 25-percent indoor water usage reduction (as this is a LEED prerequisite), while projects complying without third-party certification may claim at least 10 points for the same reduction.

The cost implications of CSDP compliance can vary significantly depending on the compliance path and specific strategies pursued. Considering CSDP compliance strategy during conceptual design and documenting it in the Owner's Project Requirements (OPR) helps cost effectiveness, as sustainability measure costs can be considered in preliminary budget exercises.

4.0 Chicago Benchmarking Ordinance Update

Since 2013, the Chicago Benchmarking Ordinance has required existing commercial, institutional, and residential buildings larger than 50,000 square feet (4,645 square meters) to track and report their whole-building energy usage.

According to the City of Chicago Mayor's Office (ibid.), this regulation covers less than 1 percent of Chicago's buildings by count, but accounts for 20 percent of total building energy usage in the city.

Specifically, the ordinance has three requirements for covered buildings (see Appendix for web link to directory of covered buildings):

1. Record building properties, (size, age, conditioning type, program) monthly energy use (typically gas and/or electricity) via the free ENERGY STAR Portfolio Manager Web tool (see Appendix for web link).

2. Have energy utility data verified by a third-party professional with an architecture license, engineering license or other city-approved accreditation.

3. Report energy use to the City of Chicago once every three years via the ENERGY STAR Portfolio Manager web tool.

To date, the City of Chicago disseminates the reported data via the Chicago Data Portal (see Appendix for web link) and a Chicago Energy Benchmarking Report published every three years—the 2018 Chicago Energy Benchmarking Report indicated a 10 percent reduction in building energy usage per square foot from that reported in the 2015 edition (City of Chicago Office of the Mayor 2018). Building owners and operators have not been required to publish or disclose their energy performance by any other means. However, starting 1 August 2019, the updated Benchmarking Ordinance implemented the Chicago Energy Rating System (City of Chicago Office of the Mayor 2019). Buildings covered by the benchmarking ordinance will be assigned a zero-to-four-star scale rating based on their performance relative to similar peers and issued a Chicago Energy Rating Placard conveying this information (see Figure 3). Building owners or managers will be required to post the rating in a visible place within their building, and to disclose the rating when the building or portion thereof is listed for sale or lease (ibid.).

The zero-to-four-star scale is derived from the building's ENERGY STAR score. After benchmarking utility data in the ENERGY STAR Portfolio Manager, the Web tool compares the building's energy usage to other buildings with similar size, age, conditioning type, and program nationally then assigns an ENERGY STAR score between 1 and 100,

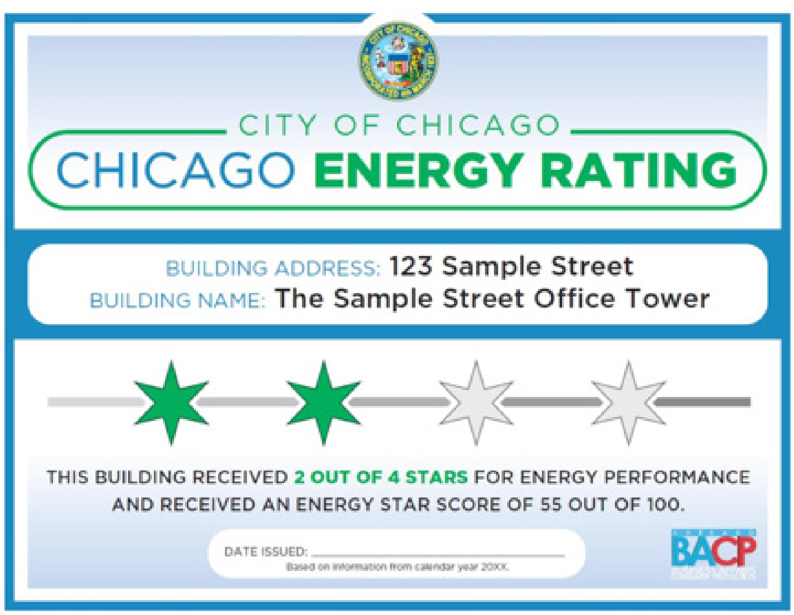

Figure 3. Chicago Energy Rating Placard showing zero-to-four-star energy performance rating. Building owners and operators must display the placard in a prominent location and report the rating when listing any portion of the building for sale or lease. © City of Chicago Office of the Mayor

based on this relative performance: a score of 50 implies better performance than 50 percent of similar buildings nationwide, while a score of 75 implies better performance than 75 percent, and so on (EPA ENERGY STAR 2019). The scoring system is detailed in Figure 4.

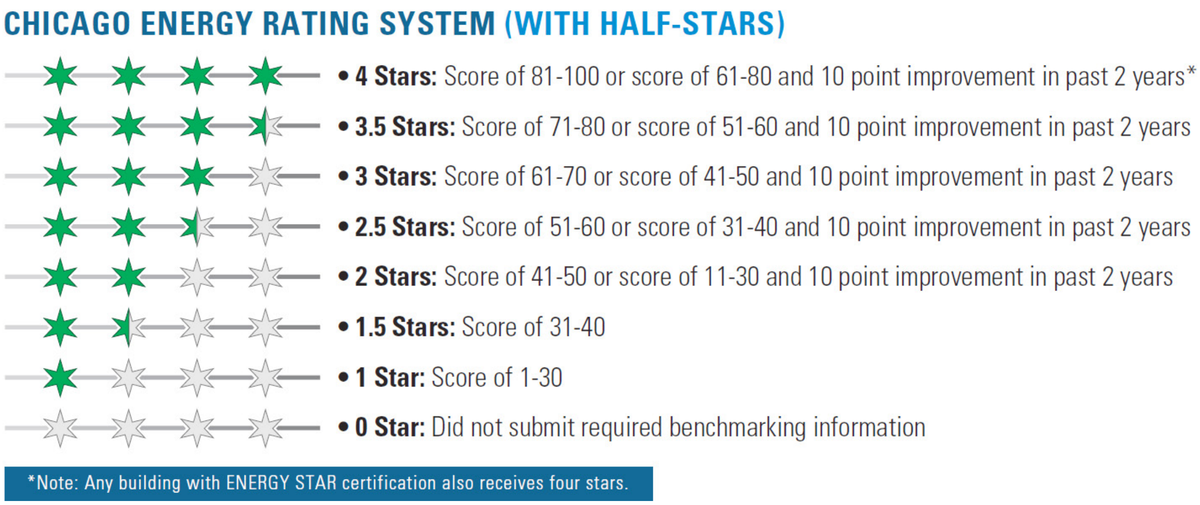

Figure 4. Chicago Energy Rating scoring system for translating ENERGY STAR scores generated by the ENERGY STAR Portfolio Manager web tool into zero-to-four-star ratings issued on Chicago Energy Rating Placards. Source: City of Chicago Office of the Mayor

Conference proceedings from the European Council for an Energy Efficient Economy (ECEEE) in 2001 (prior to the widespread implementation of energy-performance labeling in Europe) note that building energy performance labelling was perceived as an effective tool for market transformation, which, when applied to existing buildings, serves as a means to encourage owners and operators to invest in energy efficiency retrofits (Henderson, et al. 2001). This prediction has been supported by evidence: an empirical analysis of 1,100 leasing transactions in the Netherlands between 2005 and 2010 found that buildings with a "D" energy efficiency rating (equivalent to "one star") command rents 6.5 percent lower on average than do otherwise similar buildings with a "C" or better energy efficiency rating (equivalent to "two stars" or better) (Kok, Jennen 2012).

5.0 Conclusion

The recent updates to the Chicago Energy Conservation Code, Chicago Sustainable Development Policy, and Chicago Benchmarking Ordinance are serious attempts by the city to improve the energy efficiency of its existing and expanding building stock. These changing regulations can prove challenging to building owners and design teams seeking to balance mandatory sustainability goals, project budgets, and delivery timelines.

The most successful compliance strategies document goals and develop a path early in the project's conceptual design phases, to be incorporated into the Basis of Design (BOD). These strategies then continuously evaluate compliance throughout the design development process, by integrating building simulation into the design process and conducting periodic design reviews, such as those performed by a third-party commissioning provider. Employing these strategies empowers project teams to design buildings that meet both performance and budget goals with confidence.

Appendix

1. Web link for Chicago Sustainable Development Policy menu of sustainable strategies: https://www.chicago.gov/content/dam/city/depts/dcd/Projects/Draftpolicy_12_5_2016.pdf

2. Web link for directory of buildings covered by Chicago Benchmarking Ordinance: https://data.cityofchicago.org/Environment-Sustainable-Development/Chicago-Energy-Benchmarking-Covered-Buildings/g5i5-yz37/data

3. Web link for the Chicago Benchmarking Data Portal: https://data.cityofchicago.org/Environment-Sustainable-Development/Chicago-Energy-Benchmarking-2017-Data-Reported-in-/j2ev-2azp

4. Web link for ENERGY STAR Portfolio Manager: https://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/use-portfolio-manager

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About the CTBUH

The Council on Tall Buildings and Urban Habitat (CTBUH) is the world's leading resource for professionals focused on the inception, design, construction, and operation of tall buildings and future cities. Founded in 1969 and headquartered at Chicago's historic Monroe Building, the CTBUH is a not-for-profit organization with an Asia Headquarters office at Tongji University, Shanghai; a Research Office at Iuav University, Venice, Italy; and an Academic Office at the Illinois Institute of Technology, Chicago. CTBUH facilitates the exchange of the latest knowledge available on tall buildings around the world through publications, research, events, working groups, web resources, and its extensive network of international representatives. The Council's research department is spearheading the investigation of the next generation of tall buildings by aiding original research on sustainability and key development issues. The Council's free database on tall buildings, The Skyscraper Center, is updated daily with detailed information, images, data, and news. The CTBUH also developed the international standards for measuring tall building height and is recognized as the arbiter for bestowing such designations as "The World's Tallest Building."

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