Steven Winter Associates, Inc.
Improving the Built Environment Since 1972

City of Fort Collins Building Performance Standard

PERFORMANCE TARGET RECOMMENDATIONS

Typos in previously submitted version corrected below; see highlighted targets

BACKGROUND

In 2021, the City of Fort Collins, in partnership with residents and businesses, established a strategic goal to reduce 2030 greenhouse gas emissions by 80% below 2005 baseline levels. Fort Collins' buildings account for over two thirds of carbon emissions, and thus, the largest opportunity for carbon savings. The Our Climate Future plan, the community guide to creating a carbon neutral, zero waste, and 100% renewable electricity future, identified Building Performance Standards as a pathway to explore under Big Move 6: Efficient, Emissions Free Buildings.

This report recommends the Building Performance Standards, or "targets", for buildings 5,000 square feet and above located in the City of Fort Collins. Technical analysis aimed to recommend achievable targets for building types (e.g., office, retail) by the year 2030.

The theory of this technical analysis is that there is a site EUI (energy use intensity) target that is technically achievable for nearly all buildings in an occupancy type that would encourage and enable, but not require, electrification. Setting an EUI target lower than that technically achievable lower limit would result in many buildings being unable to comply.

This report describes how the targets were calculated based on locally available data, national data, and achievable energy efficiency projects.

RECOMMENDED TARGETS

Final targets, which are the numeric value of site EUI that each covered building must achieve or exceed by the final year of the performance standard, were analyzed using the CNCA EBPS tool, which is described in *Methodology* section.

The primary target analyzed is an Energy Efficiency (EE) Target. These site EUI targets would be applied to each occupancy type in a building. The EE Target assumed all energy end uses were deeply optimized and tuned through efforts such as existing system optimization, high-efficiency water fixtures and conservation, efficient appliances, and retro-commissioning where appropriate. Occupant behavior changes such as energy conservation were not considered, though conservation would also work toward this target. This target-setting method assumed that typical buildings could maintain the use of fossil-fuel burning systems for typical end uses such as space and water heating but would eliminate inefficiencies of those systems.

Numerous studies suggest economically feasible reductions of 10-30%[i,ii,iii] with an upper limit to reductions in typical buildings of 30%. The US Department of Energy (DOE) Advanced Energy Retrofit Guides list numerous measures and retrofit packages for several commercial building types without considering electrification. See *Technical References* for more detail on specific measures across a few building types.

Occupancy types with minimal gas use in the 2022 Median column have relatively smaller reductions to reach the EE target. Within a site EUI framework, all-electric buildings are typically more efficient because electricity-driven systems have fewer opportunities for energy waste, and that waste is expensive because electricity is a relatively expensive commodity compared to natural gas.

Table 1: Recommended Building Performance Targets by Occupancy Type

Occupancy Type	Baseline	Interim	EE Standard Target
	Site EUI	Site EUI	Site EUI
Adult Education	93	85	77
Ambulatory Surgical Center	128	117	105
Aquarium	133	122	112
Automobile Dealership	86	78	71
Bank Branch	101	91	82
Bar/Nightclub	279	264	249
Barracks	110	103	96
Bowling Alley	70	64	57
Casino	133	122	112
College/University	113	103	93
Convenience Store with Gas Station	286	262	237
Convenience Store without Gas Station	286	262	237
Convention Center	133	122	112
Courthouse	103	94	84
Data Center	See Below	See Below	See Below
Distribution Center	66	60	54
Drinking Water Treatment & Distribution	162	147	131
Enclosed Mall	140	130	119
Energy/Power Station	162	147	131
Fast Food Restaurant	279	264	249
Financial Office	69	63	56
Fire Station	75	68	62
Fitness Center/Health Club/Gym	74	68	61
Food Sales	286	262	237
Food Service	279	264	249
Hospital (General Medical & Surgical) (Excluded)	*208*	*191*	*173*
Hotel	77	71	65
Ice/Curling Rink	133	122	112
Indoor Arena	48	44	40
K-12 School (Excluded)	*59*	*53*	*48*
Laboratory	264	240	215
Library	76	70	63
Lifestyle Center	116	106	96
Mailing Center/Post Office	104	93	83
Manufacturing/Industrial Plant (Excluded)	*96*	*87*	*79*
Medical Office	69	63	56

Mixed Use Property	See Below	See Below	See Below
Movie Theater	112	102	92
Multifamily Housing	52	47	43
Museum	84	77	69
Non-Refrigerated Warehouse	43	40	36
Office	69	63	56
Other	81	73	66
Other - Education	93	85	77
Other - Entertainment/Public Assembly	66	61	55
Other - Lodging/Residential	80	75	69
Other - Mall	86	79	72
Other - Public Services	103	94	84
Other - Recreation	133	122	112
Other - Restaurant/Bar	251	235	219
Other - Services	70	63	56
Other - Specialty Hospital	128	116	104
Other - Stadium	133	122	112
Other - Technology/Science	162	147	131
Other - Utility	134	122	109
Outpatient Rehabilitation/Physical Therapy	128	117	105
Parking	See Below	See Below	See Below
Performing Arts	81	74	67
Personal Services (Health/Beauty, Dry Cleaning, etc.)	104	93	83
Police Station	103	94	84
Pre-school/Daycare	68	62	56
Prison/Incarceration	103	94	84
Race Track	133	122	112
Refrigerated Warehouse	76	69	61
Repair Services (Vehicle, Shoe, Locksmith, etc.)	65	59	52
Residence Hall/Dormitory	71	66	61
Residential Care Facility	110	102	94
Restaurant	251	235	219
Retail Store	60	55	49
Roller Rink	133	122	112
Self-Storage Facility	5	4	4
Senior Living Community	80	74	68
Single Family Home (Excluded)	*66*	*61*	*55*
Social/Meeting Hall	54	50	45
Stadium (Closed)	133	122	112
Stadium (Open)	133	122	112
Strip Mall	122	112	103
Supermarket/Grocery Store	180	164	148
Swimming Pool	133	122	112
Transportation Terminal/Station	133	122	112

Urgent Care/Clinic/Other Outpatient	80	73	66
Veterinary Office	98	89	80
Vocational School	93	85	77
Wastewater Treatment Plant	162	147	131
Wholesale Club/Supercenter	105	96	87
Worship Facility	43	39	35
Zoo	133	122	112

Certain use types require specific guidance:

Swimming Pools

Specific guidance can apply when swimming pools are a secondary use within a property. Heated swimming pools as a non-primary building use were identified in the 2022 benchmarking data:

- 9 entries contain *Heating Swimming Pools* as second largest property use type
- 34 entries contain *Heated Swimming Pools* as third largest property use type

SWA recommends using site EUI kBtu adjustments from ENERGY STAR Portfolio Manager. Portfolio Manager does not allow swimming pool size to be entered and instead assumes given sizes based on the pool type (recreational, short course, and Olympic). Given this, using a kBtu/SF target for pools on a per-building basis is infeasible.

Using the assumptions contained in the Swimming Pools and the ENERGY STAR Score reference, Figure 1 and the calculations contained in Figure 2 of the same link, SWA calculated the equivalent site EUI values to compare to the source EUI values

School	**ENERGY STAR Source Energy kBtu/Yr**		
	Recreational	Short Course	Olympic
	1,250,920	2,084,866	6,234,213
	ENERGY STAR Site Energy kBtu/Yr		
	Recreational	Short Course	Olympic
	1,160,077	1,933,462	5,781,480
Hotel	**ENERGY STAR Source Energy kBtu/Yr**		
	Recreational	Short Course	Olympic
	1,004,331	1,673,885	5,005,288
	ENERGY STAR Site Energy kBtu/Yr		
	Recreational	Short Course	Olympic
	925,231	1,542,051	4,611,075
Other	**ENERGY STAR Source Energy kBtu/Yr**		
	Recreational	Short Course	Olympic
	847,601	1,412,668	4,224,191
	ENERGY STAR Site Energy kBtu/Yr		
	Recreational	Short Course	Olympic
	775,964	1,293,273	3,867,174

Denver has a similar methodology and approach to the proposed site EUI-specific translation. Indoor pool calculations do not appear to have regionality built in, so the site EUI allowances can be used directly. See Appendix B2.

For outdoor pools, the impact on site energy use is relatively small, approximately 10-15% the impact of an equivalent indoor pool based on the ENERGY STAR reference linked above. Best benchmarking practices from ENERGY STAR indicate that pool energy use should be sub-metered and excluded from a Portfolio Manager entry. If this is not possible, our recommendation is to use the Denver equivalencies.

Data Centers

Data centers are listed as secondary property use types in two buildings in the 2022 Fort Collins benchmarking data. ENERGY STAR provides estimates[iv] that allow buildings to identify these spaces' energy usage. These estimates are provided due to the complexity of calculating this space type's usage and the variations between them. The ENERGY STAR estimate for data center energy use per unit of floor area is as follows:

$$Source\ Energy\ (kBtu) = 2{,}000 \frac{kBtu}{ft^2} \times Floor\ Area\ of\ Data\ Center\ (ft^2)$$[v]

However, there is a cap for the source energy of a data center if the data center's floor area is greater than 10% of the property's gross floor area, which is not frequently the case. SWA recommends referring to this guidance from ENERGY STAR to estimate energy use.

Washington DC and Denver reference this approach as well. However, the installation of a sub-meter to provide an accurate measure of data center energy data is strongly encouraged and considered a best practice.

Mixed Use Property

SWA recommends properties reporting as *Mixed Use* report their actual space use types to determine a weighted EUI target for the purpose of complying with BPS.

ENERGY STAR Portfolio Manager ESPM defines *Mixed Use* properties:

- "A Mixed Use (or multi use) property is one that contains multiple property types, none of which are *greater than* 50% of the total Gross Floor Area (GFA), *including parking GFA*."
- "Mixed Use properties can get an ENERGY STAR score and certification if they meet two criteria:
    - 75% of the property's GFA (*excluding parking*) is comprised of property types that are eligible for an ENERGY STAR score
    - At least one property type (that is eligible for certification) is more than 50% of the GFA (*excluding parking*)"[vi]

Parking

ENERGY STAR Portfolio Manager instructs users to submeter parking usage within a building then exclude that energy use and gross floor area, or if data is not submetered, include the parking square footage and Portfolio Manger will estimate parking's energy usage. Further guidance is available at:

- Parking and the ENERGY STAR Score in the United States and Canada
- How do I enter parking? (site.com)

Parking frequency was identified in the 2022 benchmarking data:

- 3 buildings list *Parking* as the primary property type
- 269 entries contain *Parking* as second largest property use type
- 19 entries contain *Parking* as third largest property use type

SWA recommends two options for determining a *Parking* target:

- Adopt elements of Denver's approach (Appendix B.3: Parking)[vii]
  - *"data"*
    - Stand-alone parking structures can also be excluded from BPS target setting
- Analyze IECC vs ENERGY STAR, adjust for Fort Collins weather
  - Revise parking EUI targets based on ENERGY STAR Technical Reference and IECC code 2018
  - Lighting power densities in the 2018 IECC are higher than the ENERGY STAR Technical Reference, but the Technical Reference includes ventilation and heating.
  - See sample below from a separate jurisdiction:

Parking Recommendations	
	Parking Area Site Energy Target (kBtu/SF/Yr)
Partially Enclosed	4.5
Completely Enclosed	7.0

IECC 2018 Table C405.3.2(1)				
	End Use	W/ft2	Operating hours/day	Parking area site energy kBtu/SF/Yr
Parking Garage	Lighting	0.15	24	4.483

2023 Adjustment Based on ENERGY STAR Reference				
Partially Enclosed	**End Use**	**W/ft2**	**Operating hours/day**	**Parking area site energy kBtu/SF/Yr**
	General Lighting	0.11	24	2.85
	Daylight Transition Zone Lighting	0.95	12	1.42
	ENERGY STAR Site EUI			4.27
Recommendation (2018 IECC)				**4.48**
Completely Enclosed	General Lighting	0.11	24	2.88
	Daylight Transition Zone Lighting	0.95	12	1.42
	ENERGY STAR Site EUI			4.30
	Recommendation (2018 IECC)			**4.48**
	Ventilation	0.29	6	2.17
		0.01	18	0.22
		Ventilation Subtotal		2.39
	Heating	0.009354	325*	0.01
TOTAL				**6.88**

METHODOLOGY

The study team reviewed the current methods utilized for setting performance standards across the country. There is not a standard methodology used across jurisdictions, therefore they are selected based on localized goals and data availability.

To identify targets, the analysis team relied on the Carbon Neutral Cities Alliance's "Performance Standards for Existing Buildings: Performance Targets and Metrics Final Report"[viii]: a methodology and workbook[ix] ("CNCA EBPS tool") created to inform technically achievable performance standards across building occupancy types. Steven Winter Associates and Sustainable Energy Partnerships authored this framework in 2020 with participation by expert advisors and government sustainability staff from around the country.[x]

The target calculations are comprised of four components; Define Paths and Targets, Typology Assignment, Baseline End Uses and Fuel Split Calculations, and Target Setting.

Define Paths and Targets

Building targets will not be useful unless based on achievable standards. These pathways, or packages of measures that can result in a building reaching a target, must be technically feasible today for each typology. The CNCA process identifies multiple target options:

- Energy Efficiency (EE) targets are determined based on an assumption of optimizing existing systems in the near term. *This is the method used to set the Fort Collins Targets.*
- More aggressive targets, such as long-term Zero Net Carbon (ZNC) targets will require replacement and electrification of major systems. *This methodology could be implemented for future targets.*
- Interim targets are developed to address technical performance limits. The most aggressive targets may not be achievable in the next 10-20 years because of equipment life, capital planning, and retrofit mobilization.
    - For example, these interim targets identify where buildings need to be in 2027 so that the 2030 goals are achievable.

Site energy use intensity (EUI) was selected as the target performance metric as a way to promote holistic energy efficiency as well as decarbonization of fossil fuel systems.

Typology Assignment

Buildings are organized by typology based on prevalence within the jurisdiction in order to identify reasonable standards for each based on similarities of use and construction types.

The activities that occur within a building, along with the size, occupancy, and equipment, determine the energy use intensity and carbon emissions. As such, setting a single performance target (i.e.. 20% reduction) would not account for these variabilities. The City of Fort Collins' performance targets were designed to be achievable for each unique building typology.

EPA's ENERGY STAR Portfolio Manager (ESPM) is the industry standard for measuring building performance and tracking progress towards goals. ESPM has 87 different property types that were developed from the Energy Information Agency's (EIA) Commercial Building Energy Consumption Survey (CBECS).

While some jurisdictions choose to group building types into fewer categories to assign targets, SWA recommends maintaining the 87 specific categories provides a more accurate representation of average building use profiles by category.

Additionally, the State of Colorado and the City of Denver utilized ESPM property types to both calculate and communicate building performance targets. Aligning Fort Collins' targets with those adopted by the Colorado Energy Office as much as possible will minimize confusion or unnecessary complication within the building energy industry across the state.

Baseline End Uses and Fuel Split Calculations

Site EUI Baselines

Energy use baselines in this technical analysis were based on calendar year 2022 energy use (weather normalized) from the City of Fort Collins, when available. In the case of limited data, where there were fewer than 10 benchmarked properties for a given use type, the most recent years of benchmarking data from Denver and Boulder were combined with Fort Collins to get a better picture of average energy usage. The recommended median baseline EUI was selected using the following hierarchy:

1. Fort Collins Benchmarking Data
2. CO Benchmarking Data
3. National CBECS Data

Note: Memos were generated on 1-24-2024 and 2-29-2024 describing this process and results in detail.

End Use Loads

Once median site EUI's were selected for each use type, target EUIs were calculated by applying feasible reductions to end uses. End use profiles in this technical analysis were based on national CBECS data and weather normalized.

This approach was selected to account for differing implications of varying fuel reductions. This methodology addresses the unique loads of differing building types, as well as the differences between gas and electric equipment efficiencies. For example, the amount of achievable heating savings for a warehouse is significantly less than what is possible for a multifamily building.

Table 2: End Use Breakdown by CBECS Property Type

CBECS Use Type	% Space Heating	% Domestic Hot Water	% Cooking	% Gas Other	% Cooling	% Plug Loads and Other
Multifamily Housing	49%	44%	7%	0%	33%	67%
Education	65%	17%	4%	14%	24%	76%
Food sales	54%	5%	41%	0%	4%	96%
Food service	18%	20%	62%	0%	20%	80%
Health care Inpatient	49%	23%	11%	17%	27%	73%
Health care Outpatient	91%	9%	0%	0%	11%	89%
Lodging	30%	56%	0%	14%	17%	83%
Mercantile Enclosed and strip malls	38%	24%	26%	12%	13%	87%
Mercantile Retail (other than mall)	71%	9%	21%	0%	16%	84%
Office	64%	12%	0%	24%	15%	85%
Other	95%	5%	0%	0%	15%	85%
Public assembly	73%	4%	13%	10%	40%	60%
Public order and safety	51%	42%	7%	0%	25%	75%
Religious worship	82%	0%	18%	0%	23%	77%
Service	70%	30%	0%	0%	17%	83%
Warehouse and storage	63%	11%	0%	26%	16%	84%
Vacant	91%	9%	0%	0%	15%	85%

End use profiles were then mapped to ESPM typologies to calculate averages using local benchmarking electricity and natural gas use data.

Target Setting

EE Targets are set for the typologies accounting for the baseline use of buildings, feasible reductions, and ultimate reduction goals. EE targets describe interim steps and performance standards that can be applied to gas-using end uses to reduce energy use without electrification. The resulting energy efficiency performance targets will not be enough to achieve zero-net carbon targets since gas and on-site combustion are implicitly allowed.

Zero Net Carbon (ZNC) targets build off the EE Target as a new baseline and converts all fuel-burning end uses to electricity using a ratio for that end use. This is included in the proposal for future consideration acknowledging Fort Collins' 2050 goals.

Achievable Reductions

To calculate feasible targets, the study team approximated what the typical building of a given occupancy type can achieve using assumptions on existing systems and their efficiency, both current and what is technically achievable. This summarizes the approach to target setting, but it does not dictate a specific retrofit package for a particular building. Any individual building would develop a scope of work that reflects how it would achieve or exceed its respective target.

The results of the following retrofits align with the Energy Efficiency (EE) target:

1. Energy efficiency improvements to all end uses that require electricity. In a carbon-neutral grid scenario, this measure reduces electricity loads and constraints on the grid when gas end uses are electrified.
2. Basic air sealing and, while not required, enhanced thermal efficiency of most commonly replaceable envelope elements (i.e., windows, roofs) may be done at end of useful life to meet targets.
3. Energy efficiency of gas-based space heating systems – such as better heating controls, duct sealing, distribution balancing. [This does not include installation of more efficient gas equipment.] Electrification of heating systems would not be required but could be done as a way to meet the target.
4. Energy efficiency domestic hot water systems – such as better controls, pipe insulation, low flow fixtures. [This does not include installation of more efficient gas equipment.] Electrification of domestic hot water systems would not be required but could be done as a way to meet the target.
5. Potential efficient electrification of cooking, laundry, and other gas process loads would not be required but could be done as a way to meet the target.

The target does not explicitly assume the addition of (a) wall insulation to the exterior of the building, (b) high performance window installations, or (c) energy recovery ventilation systems because of the limited applicability of the measures across all building types. However, these measures can greatly improve the performance of buildings and make further decarbonization possible by reducing heating and cooling loads, thereby decreasing the necessary capacity of electric heating and cooling systems. These retrofits could be implemented by any individual building in pursuit of achieving a site EUI target, but the target-setting calculations themselves do not assume the implementation of these retrofits.

To apply these assumptions, achievable percent reductions, described in Table 3, were applied to the end use of each ESPM property type.

Table 3: Achievable energy reduction percentages by end use

End Use	Assumptions	Current Fort Collins Assumptions
Baseload Electricity	Lighting efficiency improvements, appliance upgrades, plug load management, elevator replacement; basic air sealing	20%
Space Heating	Controls and distribution improvements to reduce overheating; basic air sealing	20%
Water Heating	Reduction in distribution losses and fixture GPM reductions	10%
Cooking	Improvements would require equipment replacement with more efficient options	0%
Other	*Laundry:* Point of use equipment for specific uses. Same approach as cooking *Gas Process Loads:* Various industrial and process loads (cleaning, lab equipment, etc) including laundry. Accounts for 4% of gas use nationwide. Wide range of dissimilar uses.	0%

APPENDICIES

FUTURE CONSIDERATIONS

While Fort Collins will begin with an Energy Efficiency standard, it is important to consider what targets are necessary to achieve city, state, and national goals towards carbon neutrality. As such, a Zero Net Carbon-Compatible (ZNC) target was also analyzed for future consideration.

A Zero Net Carbon-Compatible (ZNC) Target: an EUI level simulating the electrification of all fossil fuel end uses using market-ready technology in an energy efficient building. This target was intended to be compatible with Zero Net Carbon goals because it implicitly required the elimination of most on-site fuel burning.

The ZNC target assumes on-site fuel burning is eliminated through electrification, further reducing site EUI based on standard assumptions in the CNCA EBPS tool. This Zero Net Carbon-Compatible (ZNC) target can be thought of as a technically feasible limit on building energy performance for each group.

The electrification of end uses assumes that those end uses are optimized through the energy efficiency assumptions laid out in the Energy Efficiency target. While the order may not always be sequential, the technical potential of buildings would be realized by optimizing end uses, especially space heating and cooling uses and electrifying beyond those uses. Alternatively, it may be easier for some buildings, such as those with difficult-to-optimize heating systems (i.e., central steam plants) to electrify immediately and undertake the energy efficiency measures in parallel. Energy efficiency of heating and cooling may be achieved with the act of modernizing the system, enabling better control and heat delivery, instead of undertaking the often-challenging task of optimizing the existing heating systems.

The largest percentage savings required to reach the targets was in multifamily buildings, particularly older multifamily buildings, which typically have central heating and hot water systems heated by burning fossil fuels. These systems have the most potential for site EUI reduction because the heat pump systems that can replace them are efficient in comparison[11].

Table 4: Projected ZNC Targets

Occupancy Type	Baseline Site EUI	ZNC Target Site EUI
Adult Education	93	40
Ambulatory Surgical Center	128	66
Aquarium	133	58
Automobile Dealership	86	41
Bank Branch	101	55
Bar/Nightclub	279	148
Barracks	110	59
Bowling Alley	70	42
Casino	133	58
College/University	113	54
Convenience Store with Gas Station	286	172
Convenience Store without Gas Station	286	172

Convention Center	133	58
Courthouse	103	44
Data Center	tbd	tbd
Distribution Center	66	32
Drinking Water Treatment & Distribution	162	92
Enclosed Mall	140	78
Energy/Power Station	162	92
Fast Food Restaurant	279	148
Financial Office	69	43
Fire Station	75	35
Fitness Center/Health Club/Gym	74	41
Food Sales	286	172
Food Service	279	148
Hospital (General Medical & Surgical) (Excluded)	*208*	*112*
Hotel	77	49
Ice/Curling Rink	133	58
Indoor Arena	48	27
K-12 School (Excluded)	*59*	*31*
Laboratory	264	128
Library	76	42
Lifestyle Center	116	74
Mailing Center/Post Office	104	34
Manufacturing/Industrial Plant (Excluded)	*96*	*48*
Medical Office	69	41
Mixed Use Property	tbd	tbd
Movie Theater	112	67
Multifamily Housing	52	26
Museum	84	46
Non-Refrigerated Warehouse	43	21
Office	69	38
Other	81	43
Other - Education	93	40
Other - Entertainment/Public Assembly	66	35
Other - Lodging/Residential	80	46
Other - Mall	86	53
Other - Public Services	103	44
Other - Recreation	133	58
Other - Restaurant/Bar	251	110
Other - Services	70	30
Other - Specialty Hospital	128	91
Other - Stadium	133	58
Other - Technology/Science	162	92
Other - Utility	134	67
Outpatient Rehabilitation/Physical Therapy	128	66

Parking	tbd	tbd
Performing Arts	81	42
Personal Services (Health/Beauty, Dry Cleaning, etc.)	104	34
Police Station	103	44
Pre-school/Daycare	68	35
Prison/Incarceration	103	44
Race Track	133	58
Refrigerated Warehouse	76	54
Repair Services (Vehicle, Shoe, Locksmith, etc.)	65	26
Residence Hall/Dormitory	71	41
Residential Care Facility	110	65
Restaurant	251	147
Retail Store	60	32
Roller Rink	133	58
Self-Storage Facility	5	3
Senior Living Community	80	49
Single Family Home (Excluded)	*66*	*27*
Social/Meeting Hall	54	27
Stadium (Closed)	133	58
Stadium (Open)	133	58
Strip Mall	122	73
Supermarket/Grocery Store	180	115
Swimming Pool	133	58
Transportation Terminal/Station	133	58
Urgent Care/Clinic/Other Outpatient	80	46
Veterinary Office	98	51
Vocational School	93	40
Wastewater Treatment Plant	162	92
Wholesale Club/Supercenter	105	66
Worship Facility	43	18
Zoo	133	58

APPENDIX: TECHNICAL REFERENCES

Targets are intended to achieve energy efficiency savings while not specifically requiring electrification for a median performing building. These reductions are intended to use technology and best practice O&M strategies available today.

Estimated reductions are based on a range of literature on building retrofit outcomes:

- Lawrence Berkeley National Laboratory, Systems Retrofit Trends in Commercial Buildings: Opening Up Opportunities for Deeper Savings
  - https://buildings.lbl.gov/sites/default/files/Regnier%20-%20Systems%20Retrofit%20Trends.docx__1.pdf
- Berkely Lab, U.S. Building Sector Decarbonization Scenarios to 2050
  - https://buildings2050.lbl.gov/
- Lawrence Berkley Lab, Building Commissioning
  - lbnl-cx-cost-benefit-pres.pdf (lbl.gov)
- ACEEE, Moving the Needle on Comprehensive Commercial Retrofits
  - https://www.aceee.org/sites/default/files/pdfs/b2203.pdf
- Department of Energy Advanced Energy Retrofit Guides
  - https://www.energy.gov/eere/buildings/advanced-energy-retrofit-guides
- Energy Savings from GSA's National Deep Energy Retrofit Program
  - https://www.gsa.gov/system/files/NDEREnergySavingsReport5.pdf

- Fort Collins Provided Data
- Buildings Sector Report, A Technical Report of the Massachusetts 2050 Decarbonization Roadmap Study
  - https://www.mass.gov/doc/buildings-sector-technical-report/download
- Ecotope for the City of Seattle, Building Energy Use Intensity Targets Final Report
  - https://www.seattle.gov/documents/departments/ose/bldgengy_targets_2017-03-30_final.pdf
- Northwest Energy Efficiency Alliance, A Search for Deep Energy Savings NEEA's Study of Existing Building Energy Efficiency Renewals Final Report
  - https://newbuildings.org/wp-content/uploads/2015/11/NEEA_Meta_Report_Deep_Savings_NBI_Final81520111.pdf
- One City Built to Last: Transforming New York City Buildings for a Low-Carbon Future, Technical Working Group Report.
  - https://www.nyc.gov/html/gbee/downloads/pdf/TWGreport_2ndEdition_sm.pdf
- Guarini Center on Environmental, Energy & Land Use Law, Carbon Trading for New York City's Building Sector
  - https://guarinicenter.org/9430/
- Building Energy Exchange, Low Carbon Multifamily Retrofit Playbooks:
  - https://be-exchange.org/lowcarbonmultifamily-main/
- International Energy Agency Deep Energy Retrofit – Case Studies
  - https://iea-ebc.org/Data/publications/EBC_Annex%2061_Subtask_A_Case_Studies.pdf

APPENDIX: METHODOLOGY COMPARISONS

Institute for Market Transformation (IMT) BPS Model Ordinance

IMT created a BPS model ordinance which calls for the government department implementing the ordinance to:

- Sort covered buildings into groups according to property type (office, retail, etc).
- Create more targeted categories if desired (affordable housing, convenience stores separate from grocery, etc).

Ambitious but achievable final performance standards are set for each property type by a specified future date

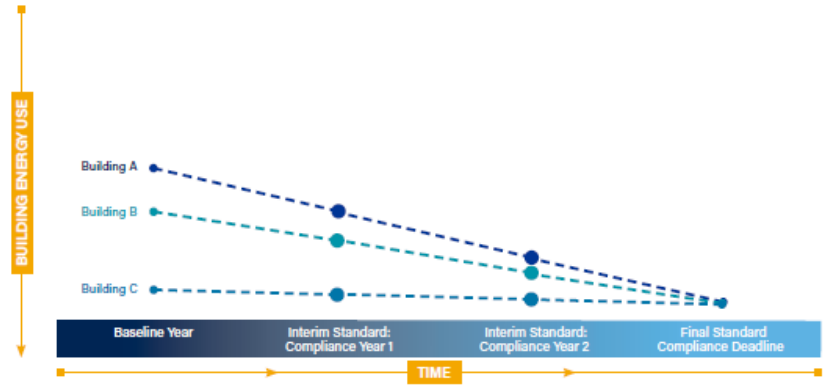
- IMT recommends setting final performance standards 15-30+ years in the future. This long timeframe will allow almost all buildings to encounter at least one opportunity to make a capital investment to dramatically improve performance, such as replacing a roof or HVAC system.
- IMT recommends an interim performance standard to ensure that buildings make progress toward the final performance standard, in five-year intervals

A “trajectory approach” identifies interim standards for each individual building to reflect its baseline performance. The ordinance assumes that performance data is available for covered buildings for each of the standards included in the ordinance or that needed data will be collected as the first step in implementing the ordinance.

The diagram below illustrates how a department determines each individual building’s trajectory and interim performance standards.

- The building’s performance level in the baseline year and its required performance in the final year are plotted.
- Three multifamily buildings must meet the same standard, but have different improvement slopes based on their starting performance; Building A has a higher EUI and must reduce energy more dramatically than Building C which only needs to maintain current levels of efficiency.

Diagram 1: The IMT BPS Trajectory Approach



The final page of the guidance document shares a recommends use of the CNCA tool: https://www.imt.org/resources/imt-model-bps-ordinance-summary/

Colorado

Each covered building must meet a maximum site EUI standard based on its occupancy type by the year 2030. CO owners can also elect GHGI targets.

- Buildings are required to meet interim performance targets in 2026 to ensure progress toward the final, 2030 standard.
- Interim targets are determined according to the building's "trajectory" from its baseline site EUI performance in 2019 to the final site EUI standard for its property type.

Denver, CO

Denver employed IMT's BPS "trajectory approach" from their Model Ordinance.

Denver worked with an engineering firm to analyze benchmarking data and national CBECS data to determine EUI performance standards for covered property types.

Each covered building must meet a maximum site EUI standard based on its occupancy type by the year 2030. Buildings are required to meet interim performance targets in 2024 and 2027 to ensure progress toward the final, 2030 standard. Interim targets are determined according to the building's "trajectory" from its baseline site EUI performance in 2019 to the final site EUI standard for its property type.

There are over 70 building types with specific site EUI targets for 2030. There are several unique building types (e.g., museums, convention centers, etc.) for which Denver was not able to set a specific Site EUI target for 2030. Instead, buildings of these types must achieve a 30% Site EUI reduction from their 2019 baseline.

Boston, MA

Boston hired a consulting company, Synapse Energy Economics, to recommend GHG standards for each covered property type and to estimate the cost of common emission abatement strategies.

Property types are organized by ENERGY STAR Portfolio Manager building types, and each property type has its own GHG target starting in 2025 until 2050 where all buildings are limited to 0. Targets become more stringent every 5 years. Building owners can apply for an individual compliance schedule achieving 50% emissions reduction by 2030 and 100% by 2050 using a 2005 or later baseline.

Montgomery County, MD

Montgomery County set specific EUI standard by building type with interim and final standards. Targets were set using the CNCA tool methodology.

New York, NY

New York City used audit data collected under its Local Law 87 to analyze the most cost-effective energy and GHG reduction strategies in its large building stock.

Goals include reducing aggregate GHG emissions from covered buildings by 40% in 2030 and 80% by 2050 relative to 2005 levels. This will be achieved through gradual improvements outlined in compliance cycles of 5 years, beginning in 2024.

Emissions limits for various building class types are outlined for compliance periods of five years starting in 2024, becoming more stringent each period.

Washington DC

Washington, DC set most of its standards for most property types at the local median ENERGY STAR score for each property type. The city worked with C40 Cities and Lawrence Berkeley National Laboratory to estimate the costs and savings at the building level.

The building energy performance standard shall be no lower than the District median ENERGY STAR score for buildings of each property type. The city will issue new performance standards every six years, and will set campus-wide standards for educational campuses and hospitals.

Chula Vista, CA

Compliance cycle occurs every five years. One target is based on ENERGY STAR scores:

- Baseline ENERGY STAR Scores of 0-45 have an improvement target of 30%
- 46-65 of 20%
- 66-79 of 10%

Alternatively, properties may comply by reducing their EUI as compared to the baseline measure.

- Baseline EUI-WN of 80+ have a reduction target of 30%
- 51-79 of 20%
- 19-50 of 10%

These targets refresh with every compliance cycle and are subject to change.

Additionally, there is a minimum improvement target buildings must meet every 10 years. This involves minimum improvements of 15% for baseline Energy Star scores of 0-45 and 10% for 46-65.

Additional requirements include:

- Annual benchmarking through Energy Star Portfolio Manager
- Energy audits in conformance with ASHRAE Standard 211 at Level 1 or greater to be completed every five years.
- Retrocommissioning is to be completed every five years in buildings containing 50,000 SF of conditioned space, including HVAC, lighting, water heating, and renewable energy systems

Washington

Washington used an amended version of *ASHRAE Standard 100 – Energy Efficiency in Existing Buildings* to set EUI targets for covered properties. EUI targets must be no greater than the average energy use intensity for the building's occupancy type with adjustments for unique energy-using features. Proposed rules set first target at 15% below average EUI for building type.

Rather than estimate compliance costs for covered properties, the state wrote a requirement into its law that buildings that do not meet the standard on their own by the compliance deadline will go into a conditional compliance path.

These owners are required to conduct an energy audit and energy management plan that uses life-cycle cost analysis to determine a bundle of measures that will meet the standard with a savings-to-investment ratio of 1.0 or greater. Thus, no owner will be required to pay for uneconomic improvements.

Maryland

Existing buildings over 35,000 square feet achieve a 20% reduction in net direct greenhouse gas emissions on or before January 1, 2030, as compared with 2025 levels for average buildings of similar construction; and net–zero direct greenhouse gas emissions on or before January 1, 2040.

Saint Louis, MO

Standards to be set no lower than the 65th percentile by property type, so that at least 65% of the buildings of the property type have a higher EUI. The Office of Building Performance will issue new performance standards at the end of each compliance cycle.

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[i] NYC Buildings Technical Working Group. See Rudin Management case study, page 71, among others: https://www1.nyc.gov/assets/sustainability/downloads/pdf/publications/TWGreport_04212016.pdf

[ii] https://www.aceee.org/sites/default/files/publications/researchreports/a1402.pdf

[iii] DOE Advanced Energy Retrofit Guides (AERGs) for various commercial building types, also detailed in Appendix III: https://www.energy.gov/eere/buildings/advanced-energy-retrofit-guides

[iv] Data Center Estimates in the United States and Canada (energystar.gov)

[v] https://www.energystar.gov/sites/default/files/tools/Data_Center_Estimates_August_2018_EN%20-%20508%20Blue.pdf

[vi] https://portfoliomanager.energystar.gov/pm/glossary?_gl=1*3hftae*_ga*MTM3MjU2OTk0Mi4xNzAxNzE3NjE5*_ga_S0KJTVVLQ6*MTcwMzA4NDA3My4yLjAuMTcwMzA4NDA3My4wLjAuMA..#FinancialOffice

[vii] https://denvergov.org/files/assets/public/v/1/climate-action/documents/energize-denver-hub/ed-technical-guidance-buildings-25000-sq-ft-and-larger-v2_june-2023_clean.pdf

[viii] http://carbonneutralcities.org/wp-content/uploads/2020/03/CNCA-Existing-Building-Perf-Standards-Targets-and-Metrics-Memo-Final-March2020.pdf

[ix] http://carbonneutralcities.org/wp-content/uploads/2020/03/CNCA-Existing-Building-Perf-Standards-Targets-Workbook-Final.xlsx

[x] Slide 4. http://carbonneutralcities.org/wp-content/uploads/2020/03/CNCA-Existing-Building-Perf-Standards-Project-Summary-Final.pdf

[11] Hopkins, Takahashi, Glick, Whited. “Decarbonization of Heating Energy Use in California Buildings”. October 2018. Synapse Energy Economics, Inc. Page 10 says “*Because a heat pump moves heat rather than generating it, the efficiency of heat pumps can be over 100 percent… for heating season, heat pumps could typically have a COP exceeding 3, meaning a heat output 300 percent of the energy input.”* This 300% efficiency is much more efficient than the <95% efficient gas equipment that a heat pump would replace.