City of Fort Collins Building Performance Standard

CASE STUDY SUMMARY

BACKGROUND

Steven Winter Associates (SWA) is developing case studies of representative buildings within the most prevalent typologies covered by a proposed Fort Collins BPS. These case studies identify buildings that will have to invest in energy efficiency improvements to test model assumptions and help inform larger costs and savings.

PROCESS

The largest occupancy types within the 2022 benchmarking data based on ENERGY STAR were identified:

Rank	Occupancy Type	Count	%
1	Office	241	20.6%
2	Multifamily housing	154	13.2%
3	Retail store	76	6.5%
4	Worship facility	61	5.2%
5	Strip mall	40	3.4%
6	Non-refrigerated warehouse	37	3.2%
7	Other	37	3.2%
8	College/university	36	3.1%
9	Medical office	34	2.9%
10	Laboratory	33	2.8%
10	Restaurant	33	2.8%

Worship Facilities were originally recommended to be excluded from case studies as they can vary widely in system type, construction type, and age and often contain unique systems. The common factor for these properties is the decision-making structure and financial constraints, rather than assumed physical similarities.

SWA worked with the City of Fort Collins to identify candidates where utility data, building information, and building staff were available to gather needed information. Buildings ideally represented some of the most common occupancy types, and performed at or above their respective median (average or more than average energy use) to identify common paths to energy reductions.

The case studies are desktop audits based on phone interviews and provided drawings and other documentation. Analyses are conducted with assumed energy savings based on available research and cost estimates are based on existing research studies, industry experience, and data provided by the City of Fort Collins.

FINDINGS

Three of four targeted case studies have been completed. These case studies identify differing compliance scenarios potentially presented to buildings:

Case Study	Occupancy Type	Purpose	Estimated Cost/ SF
1	Office	Moderate energy savings required (9% reduction)	$2.85
2	Multifamily Housing	Energy savings cap (25% Reduction)	$4.44
3	Retail Store	Energy savings cap (25% Reduction)	$4.36

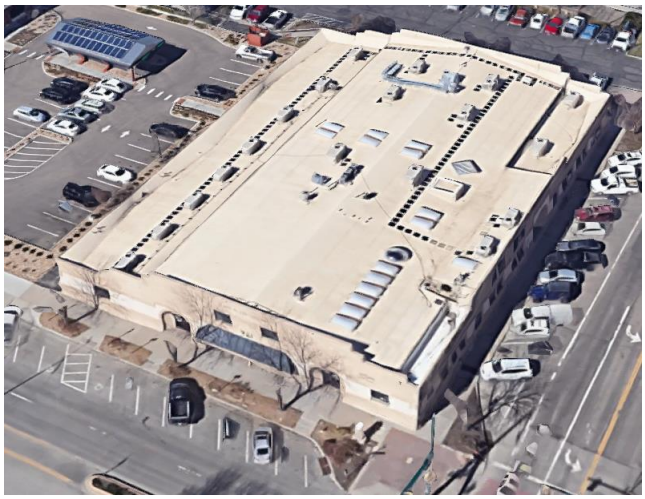
Case Study 1 highlights an office property with well-maintained existing systems and acts as an average use case. Here, improved HVAC controls and other cost-effective measures can reduce energy usage to meet the target. Major system or envelope component replacement is not required.

Case Studies 2 & 3 identified properties where more substantial action is needed as their existing energy performance meets the standard triggering the 25% reduction cap. Both properties have opportunities to replace equipment at or near the end of useful life with higher performance equipment. The cost per square foot figures are similar in the two cases although the approaches were different. In Case Study 2, other envelope improvements had already been instituted, except for windows which date to the original construction of the property. In Case Study 3, the existing heating equipment can be replaced with a definite high performance alternative appropriate to this building type.

Providing case studies of buildings with the maximum required reduction allows for an understanding of the top end of what may be required, rather than insight into what an average building may need to do. This has dual benefits in both allowing confirmation that the EUI reduction cap is appropriate based on projected costs to meet the cap, and in demonstrating upgrades and alterations that would have the most effect in reducing EUI.

CASE STUDY 1: OFFICE

281 North College Avenue is an office building that houses building services employees for the City of Fort Collins. It is comprised of two lobby areas, offices, conference rooms, restrooms, and storage space. The occupied hours set for the building are Monday through Friday, 7:00 am to 5:00 pm.



The envelope consists of double-paned windows, a roof with an estimated R-20 level insulation, and some assumed batt insulation within the block walls. The building was originally a lumber facility with storage but was refinished from this use into an office space roughly 16 years ago.

Electricity is provided to the building by Fort Collins Utilities under the E300 rate. This rate utilizes a monthly electric energy usage charge and a monthly facility demand change. Natural gas is provided by Xcel Energy.

Heating, cooling, and ventilation are provided by 19 constant volume units with DX cooling, gas heating, and economizers that were installed in 2009. The building also has 8 gas furnaces with split DX systems and a minimum fresh air requirement that help provide heating. The rooftop units are controlled by individual Viconics thermostats that are wirelessly networked to the JCI controls system for monitoring; this is integrated into the enterprise City of Fort Collins building automation system. A schedule is set to set back temperatures during unoccupied hours and weekends: 65 °F during the heating season and 85 °F during the cooling season. Domestic hot water for the restrooms is provided by natural gas boilers that were installed in 2010. The lighting is mostly comprised of T-8 fluorescents, however there are some LEDs already installed. The other major source of electricity consumption in the building is the basic office equipment used.

BUILDING INFORMATION

Property Use Type	Office
Name	Fort Collins City Services Building
Address	281 North College Ave Fort Collins, CO 80524
SF	37,603

Basic System Information

Category	Type	Fuel	Approximate Equipment Age (Years)
Central Building Management System (BMS)	A schedule is used to set back temperatures during unoccupied hours and weekends: 65 °F during the heating season and 85 °F during the cooling season. The occupied hours are Monday through Friday, 7:00 am to 5:00 pm.	N/A	unknown
Heating	19 constant volume rooftop units with DX cooling, gas heating, and economizers. 8 gas furnaces with split DX systems and minimum fresh air intake	Natural gas	15
Cooling	19 constant volume rooftop units with DX cooling, gas heating, and economizers.	Electric	15
Ventilation	Provided for the building by the RTUs and split DX system with minimum outdoor air intake.	Electric	15
Domestic Hot Water (DHW)	Natural gas boilers	Natural gas	14
Lighting	Primarily T8 fluorescent	Electric	unknown
Envelope	Windows: double-paned Wall: Brick and block construction Roof insulation: Est R-20	N/A	16
Metering	Electricity: provided by Fort Collins Utilities under the E300 rate utilizing a monthly electric energy usage charge and a monthly facility demand change. Natural gas: purchased from a gas wholesaler.	Electric/ Gas	N/A

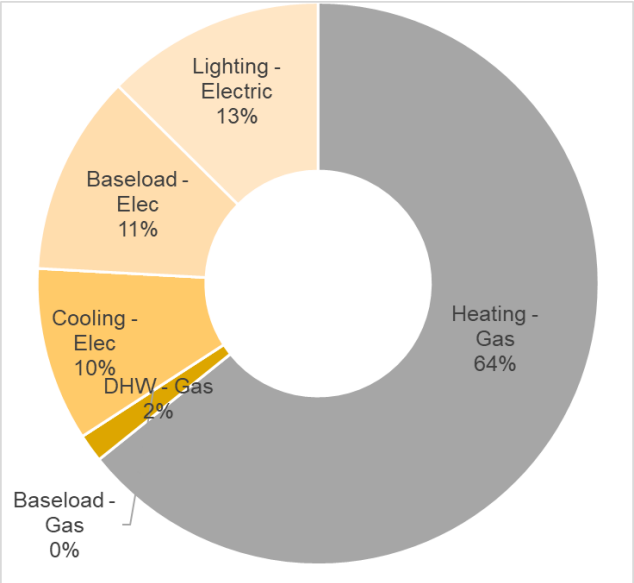
Utility End Use Assessment

The buildings' energy types and estimated end uses are composed of the following fuels:

- Natural Gas: Used primarily for heating and domestic hot water.
  - Accounts for 67% of energy use.
- Electricity: Electricity is used for cooling, ventilation, lighting, and office equipment plug loads.
  - Accounts for 33% of energy use.

Heating - Gas	Cooling - Gas	DHW - Gas	Baseload - Gas	Heating - Elec	Cooling - Elec	DHW - Elec	Baseload - Elec	Lighting - Electric	Total EUI
41.9	0.0	1.0	0.0	0.0	6.2	0.0	7.1	7.8	**64.1**
65%	0%	2%	0%	0%	10%	0%	11%	12%	**100%**

Note that the total EUI represented here may slightly differ from the ENERGY STAR Portfolio Manager calculated weather normalized EUI in the Fort Collins benchmarking data. This is due to the analysis and weather normalization required to estimate end uses between the fuels and differing approaches. The analysis here is based on actual monthly utility data for 2022.



Assumed Energy Prices

Utility rate assumptions were provided by the City of Fort Collins

- Natural Gas: $0.79/ therm
- Electricity: $0.09/ kWh

While energy rates differ by service class and usage profile, these rates are assumed to represent the average costs for these types of buildings Fort Collins.

BPS EUI TARGET AND RECOMMENDED ENERGY EFFICIENCY MEASURES

Fort Collins City Services Building's 2022 estimated EUI for the purpose of this study is 61.9 kBtu/ SF. This is 11% lower than the median performance of a Fort Collins office building of 68.8 kBtu/ SF.

The EUI target for Office buildings is 56.4 kBtu/ SF.

This represents a 9% reduction in energy performance.

Recommended Measures

A summary table is below highlighting the recommended energy efficiency measures (EEMs). Costs are estimated to represent the total cost for equipment replacement. Where noted, incremental upgrade costs are calculated by comparing the difference in the upgrade cost as compared to a "business as usual" (BAU) replacement. These costs do not include estimated incentives.

#	Measure	EUI Savings (%)	Cost Savings ($/yr)	Measure Cost ($)	Simple Payback (Years)
1	Upgrade HVAC Controls	7.7%	$2,887	$100,000	34.6
2	LED Lighting Upgrade	3.2%	$1,990	$7,145	3.6
Total		**10.8%**	**$4,877**	**$107,145**	**22.0**
Cost/ SF		**$2.85**			

Resulting EUI

Value	Heating - Gas	Cooling - Gas	DHW - Gas	Baseload - Gas	Heating - Elec	Cooling - Elec	DHW - Elec	Baseload - Elec	Lighting - Elec	Total EUI
Resulting EUI	37.1	0.0	1.0	0.0	0.0	5.9	0.0	5.3	5.9	**55.2**
Reduction	7%	0%	0%	0%	0%	4%	0%	25%	25%	**11%**

Measure Descriptions

The purpose of the package of measures is to identify load reduction and energy efficiency measures to meet its respective target.

Fossil fuel equipment replacement is avoided as it can carry 15-20 year lifespans which may not meet future, stronger energy efficiency or GHG-reduction targets prior to EUL.

Heating and DHW system electrification is only recommended where it may present a relatively cost-effective opportunity based on site conditions, or no other feasible path is present. Electrification of heating or DHW will almost certainly enable most buildings to meet the target. The intent of this study and prospective targets, however, is to identify improvement of existing systems, including those that require fossil fuels.

Upgrade HVAC Controls

The existing heating and cooling system is controlled by a wireless central BAS. The controls permit night setbacks and temperature setbacks as needed. The RTU units are assumed to be constant volume which makes individual zoning and control not feasible.

More robust wired controls can better manage temperatures and institute temperature setbacks. Additionally, an updated controls system could conceivably control fresh air dampers on the units which balance between return air and fresh air. Overnight, the dampers could be controlled to reduce conditioned air loss during unoccupied periods.

Savings assumptions assume a combination of improved temperature setbacks and control of RTU dampers.

LED Lighting Upgrade

Interior lighting is primarily non-LED. LED replacement of existing fixtures, coupled with appropriate scheduling, will result in substantial savings for assumed lighting energy use.

Measures Reviewed but Not Recommended

Multiple measures were reviewed but not included in this study:

Retro-Commissioning

The building regularly engages with city staff to ensure equipment is maintained and calibrated on a routine basis. The HVAC system has also been tested and balanced periodically. No additional savings are expected from further analysis.

Electrification

The buildings' HVAC layout lends itself to heating electrification – the existing gas-fired RTU units could be replaced with heat pump equivalents. Building management has noted familiarity and past experience with heat pump replacements of this nature and are recommended at the end of useful life of the existing equipment. Electrification of the heating system would ensure the building surpasses an energy efficiency target.

Roof Insulation

This significant roof area to square footage ratio warrants investigation of roof insulation potential. The existing roof, however, is assumed to have already R-20 levels of insultation; recommended values would be to increase to R-30, but the cost/ benefit of this approach is not assumed to be worthwhile.

CASE STUDY 2: MULTIFAMILY

Eagle Tree is a complex of multi-family apartments that was built in 1997. It is comprised of three (3), three-story walk-up buildings with 2- and 3-bedroom apartments with a total of 36 apartments. The complex also includes a clubhouse and a pool for residents' use.

The envelope consists of vinyl windows and sliding doors and R-30 Batt insulation in the walls, both original to the building. The complex completed a weatherization project in 2016 where the following improvements were implemented: R-38 blown insulation in the attic and basement crawl space, low-flow faucets, new refrigerators, and weatherstripping on the windows.

Each apartment unit is directly metered for gas and electricity. The clubhouse is separately metered. The electric and gas use of the clubhouse, the exterior lighting, and the common area maintenance are paid by ownership.

Apartment heating is provided by 36 decentralized forced-air gas-fired furnaces; a small number of which have been replaced since construction. The temperature of each apartment is individually controlled by the residents. Each apartment has a through-the-wall AC unit in the living room, most of which have been replaced in the last decade. Additionally, many residents choose to add additional window units to their other spaces. DHW is provided by individual natural gas water heaters located next to the furnaces in the mechanical closet of each apartment; these were installed roughly 10 years ago. Each bathroom contains an exhaust fan that operates with the light switch for ventilation. Cooking is provided by an electric stove in each apartment. Lastly, lighting is mostly comprised of LEDs, including exterior lighting, except for fluorescents lamps in kitchens.

Ownership runs an annual assessment for all properties which determines the upgrades each property requires in the short and long term. Eagle Tree has access to a low-income housing tax credit on a schedule of 20-30 years for approved upgrades and renovations. The upcoming cycle starts in 2026 for financing and closes in 2028 which is when renovations can begin. With these upgrades, Eagle Tree aims to meet recent energy efficiency standards and increase efficiency as much as possible without putting a burden on the residents.

BUILDING INFORMATION

Property Use Type	Multifamily
Name	Eagle Tree
Address	6675 S Lemay Avenue Fort Collins, CO 80525
SF	71,388
Units	36

Basic System Information

Category	Type	Fuel	Approximate Equipment Age (Years)
Central Building Management System (BMS)	None. Tenants control own thermostats. Clubhouse has scheduled heating and cooling times.	N/A	27
Heating	Decentralized, forced-air gas-fired furnaces. One in each apartment.	Natural gas	27 (Majority)
Cooling	Through-wall AC units provided in living rooms. Residents can add window units.	Electric	< 10
Ventilation	Exhaust fans in bathrooms that operate on a switch w/ the light.	Electric	27
Domestic Hot Water (DHW)	40 gallon water heaters in each apartment	Natural gas	10
Lighting	Mostly converted to LED. 4ft florescent lights in kitchens.	Electric	5 (estimate)
Envelope	Windows: vinyl Walls: R-30 Batt Insulation Roof: R-38 Blown in insulation in the attic	N/A	27
Metering	Apartments are direct metered (gas and electric)	Electric/ Gas	n/a

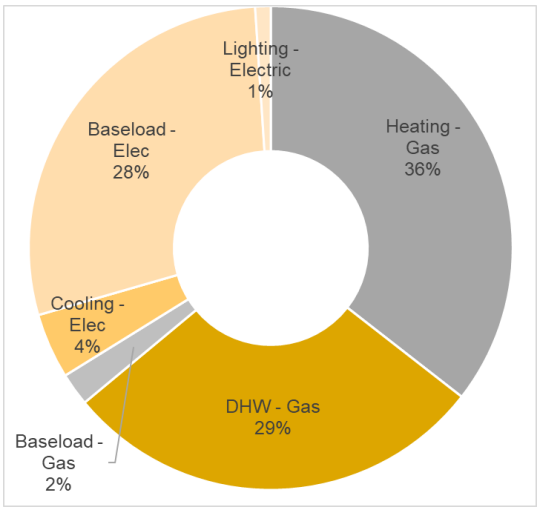
Utility End Use Assessment

The buildings' energy types and estimated end uses are composed of the following fuels:

- Natural Gas: Used primarily for heating and domestic hot water. The building also contains an outdoor pool which is assumed in operation throughout the summer which may require heating.
    - Accounts for 66% of energy use.
- Electricity: Electricity is used for cooling, ventilation, cooking, and resident plug loads.
    - Accounts for 34% of energy use.

Heating - Gas	Cooling - Gas	DHW - Gas	Baseload - Gas	Heating - Elec	Cooling - Elec	DHW - Elec	Baseload - Elec	Lighting - Electric	Total EUI
25.9	0.0	20.7	1.6	0.0	3.2	0.0	20.7	0.8	**72.9**
36%	0%	28%	2%	0%	4%	0%	28%	1%	**100%**

Note that the total EUI represented here may slightly differ from the ENERGY STAR Portfolio Manager calculated weather normalized EUI in the Fort Collins benchmarking data. This is due to the analysis and weather normalization required to estimate end uses between the fuels and differing approaches. The analysis here is based on actual monthly utility data for 2022.



Assumed Energy Prices

Utility rate assumptions were provided by the City of Fort Collins

- Natural Gas: $0.79/ therm
- Electricity: $0.09/ kWh

While energy rates differ by service class and usage profile, these rates are assumed to represent the average costs for these types of buildings Fort Collins.

BPS EUI TARGET AND RECOMMENDED ENERGY EFFICIENCY MEASURES

Eagle Tree's 2022 estimated EUI for the purpose of this study is 72.9 kBtu/ SF. This is 29% higher than the median performance of a Fort Collins multifamily building of 51.9 kBtu/ SF.

The EUI target for Multifamily buildings is 42.7 kBtu/ SF.

This represents a 41% reduction in energy performance. As a result, a 25% cap on required energy reduction is calculated here to estimate the likely performance requirements for this building.

Recommended Measures

A summary table is below highlighting the recommended energy efficiency measures (EEMs). Costs are estimated to represent the total cost for equipment replacement. Where noted, incremental upgrade costs are calculated by comparing the difference in the upgrade cost as compared to a "business as usual" (BAU) replacement. These costs do not include estimated incentives.

#	Measure	EUI Savings (%)	Cost Savings ($/yr)	Measure Cost ($)	Simple Payback (Years)
1	Retro-Commissioning	5.7%	$4,039	$24,986	6.2
2	Window Replacement	6.9%	$2,989	$202,028*	67.6
3	Whole Building Air Sealing	2.3%	$1,036	$52,827	51.0
4	Smart Thermostats	2.1%	$845	$10,708	12.7
5	HVAC Duct Sealing	0.6%	$235	$10,708	45.5
6	Low Flow Aerators	5.6%	$2,283	$1,080	0.5
7	Refrigerator Replacement	2.1%	$2,905	$14,440	5.0
Total		**25.1%**	**$14,333**	**$316,737**	**22.1**
Cost/ SF		**$4.44**			

* Window replacement calculated as incremental cost as compared to BAU. See description below.

Resulting EUI

Value	Heating - Gas	Cooling - Gas	DHW - Gas	Baseload - Gas	Heating - Elec	Cooling - Elec	DHW - Elec	Baseload - Elec	Lighting - Elec	Total EUI
Resulting EUI	15.9	0.0	15.4	1.5	0.0	3.0	0.0	18.0	0.8	**54.6**
Reduction	38%	0%	26%	6%	0%	6%	0%	13%	0%	**25%**

Measure Descriptions

The purpose of the package of measures is to identify load reduction and energy efficiency measures to meet its respective target.

Fossil fuel equipment replacement is avoided as it can carry 15-20 year lifespans which may not meet future, stronger energy efficiency or GHG-reduction targets prior to EUL.

Heating and DHW system electrification is only recommended where it may present a relatively cost-effective opportunity based on site conditions, or no other feasible path is present. Electrification of heating or DHW will almost certainly enable most buildings to meet the target. The intent of this study and prospective targets, however, is to identify improvement of existing systems, including those that require fossil fuels.

Retro-Commissioning

Retro-commissioning (RCx) is the process of ensuring systems are designed, installed, functionally tested, and capable of being operated and maintained according to the owner's operational needs. It is a crucial process for maintaining existing building performance and is generally recognized as the first stage in the building upgrade process. Starting a staged upgrade approach with RCx accounts for interaction among energy flows within a building and ensures a systematic method to target the greatest possible energy savings. This process is always site-specific but is an effective real-world intervention.

Industry research estimates whole building energy savings can range widely from 5% to 30%, making precise estimates difficult. The RCx scope of work can vary widely depending on the needs of a building and available budget. Buildings where the existing building automation system (BAS) had more visibility into terminal equipment is assumed to have a higher percentage savings.

Window Replacement

The buildings windows and balcony doors date to the construction of the building and are at or near the end of useful life. In this case, calculating the marginal cost of replacement between the already needed BAU replacement and a high-performance alternative is deemed appropriate.

- The BAU cost is estimated at $457,600. This includes a 25% adder for design and construction management fees.
- The high-performance alternative is estimated at $659,700. This includes a 25% adder for design and construction management fees.
- The marginal cost difference displayed here is $202,100.

This 25% increase estimated for a recommended design and construction management process to ensure appropriate details are implemented to result in an effective upgrade.

High-performance windows are estimated with a U-Value of 0.17. Savings also include improved air sealing from installation and weatherstripping. Passive house certified or equivalent windows are often triple paned with generous thermal breaks and gasketing and hardware that ensure airtightness.

Air Sealing

Further whole building air sealing is recommended to seal any potential openings or leakages to the exterior and joints, doors, and wall penetrations. Sleeve A/C units can be better sealed and fit within openings to minimize uncontrolled air movement and heat loss.

Smart Thermostats

Programmable thermostats can be installed to better manage heating consumption. While furnaces are managed individually and heating is paid for by residents, a level of savings can be expected which reduced overheating and implementing smart schedules.

HVAC Duct Sealing

Reducing air leakage from forced-air system ducts is a direct method of reducing energy usage and improving comfort. Losses from ducts within non-conditioned spaces can result in a significant amount of energy waste while those located in conditioned space can still improve temperature control even with reduced energy savings potential.

This study cannot calculate actual duct leakage levels within the building, however a conservative estimate of savings is assumed based on system type and equipment age.

Low Flow Aerators

Low flow aerators were installed in 2016 during a weatherization process. The assumption here is that after this amount of time, aerators need replacement or re-installation to meet low flow rate targets. These values are assumed at:

- 1.5 gpm for kitchens
- 1.0 gpm for bathrooms
- 1.5 gpm for showers

Refrigerator Replacement

Equipment was replaced in 2016 as part of the weatherization process. Equipment will be over 10 years old by the BPS compliance period. Upgrades to ENERGY STAR labeled equipment is recommended.

Measures Reviewed but Not Recommended

Multiple measures were reviewed but not included in this study:

Wall, Roof, and Crawlspace Insulation

The building already addressed roof and crawlspace insulation during the weatherization process, and already contains insulation within the walls. No additional cost-effective options remain.

LED Lighting

Most lighting had already been converted to LED except for kitchen fixtures.

Electrification

The buildings' size and decentralized heating and DHW systems make it a candidate for available electrification technologies. Heating electrification can be accomplished through heat pump integration into the existing furnace infrastructure, mini-spilt technology (which would require placement of condensers) and through-wall package terminal heat pumps (PTHPs) (which would require sufficient dimensions for existing sleeves).

Individual heat pump DHW heaters can replace the existing equipment, however an adequate pathway for venting would be required.

Cooking is already electrified.

CASE STUDY 3: RETAIL STORE

Ulta is a retail space that opened in 2008 located within a strip of other large retail structures with adjacent exterior walls. This location is a part of a larger national chain with locations throughout the US. The store has a small frontage at the front and back of the store and a large, flat roof.

Ulta leases the space from a property owner. The roof is the owner's responsibility, while the envelope, including the outer front and back and the interior walls, and mechanical systems are Ulta's responsibility. Ulta is directly metered for all utilities.

Heating and cooling are provided by four (4) packaged rooftop units: two for the sales floor, one for the salon, and one for the office and back of house space. The domestic hot water system was replaced in 2019 with a gas-fired unit; water use is minimal in the space and is used only for the salon and bathrooms. The salon and bathrooms also contain exhaust fans for ventilation. The HVAC system is controlled by a Building Automation System (BAS) that operates based on occupied and unoccupied hours. Lighting in primarily non-LED lighting.

As an organization Ulta assesses the performance and capital needs of each location to determine upgrade priorities. Internally, Ulta has carbon reduction goals they use to increase the energy efficiency of their stores to meet sustainability targets and increase comfort and store experience.

This Ulta location is scheduled for a 2024 upgrade which includes an LED retrofit, HVAC replacement, and other interior improvements.

BUILDING INFORMATION

Property Use Type	Retail Store
Name	Ulta
Address	4405 Corbett Dr., Fort Collins, CO 80525
SF	10,080

Basic System Information

Category	Type	Fuel	Approximate Equipment Age (Years)
Central Building Management System (BMS)	Yes - Tied to occupancy and operating schedule	All	4
Heating	(4) Rooftop RTU	Natural Gas	16
Cooling	(4) Rooftop RTU	Electricity	16
Ventilation	Exhaust fans for the salon and restrooms	Electricity	16
Domestic Hot Water (DHW)	Single AO Smith hot water heater	Natural Gas	5
Lighting	Primarily non-LED	Electricity	16
Envelope	Small street frontage; located between two buildings. Large roof responsibility of the landlord.	n/a	16
Metering	Direct metered for energy usage.	n/a	n/a

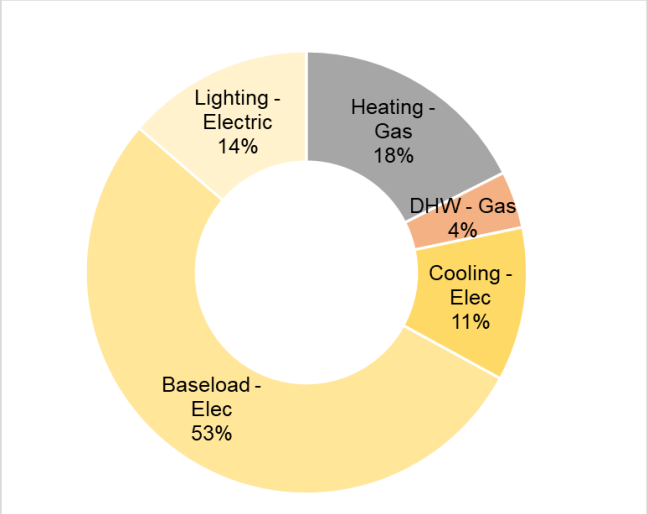
Utility End Use Assessment

The buildings' energy types and estimated end uses are composed of the following fuels:

- Natural Gas: Used primarily for heating and domestic hot water.
  - Accounts for 22% of energy use.
- Electricity: Electricity is used for cooling, ventilation, and plug loads.
  - Accounts for 78% of energy use.

Heating - Gas	Cooling - Gas	DHW - Gas	Baseload - Gas	Heating - Elec	Cooling - Elec	DHW - Elec	Baseload - Elec	Lighting - Electric	Total EUI
18	0	4		0	12	0	55	14	**103**
18%	0%	4%	0%	0%	11%	0%	53%	14%	**100%**

Note that the total EUI represented here may slightly differ from the ENERGY STAR Portfolio Manager calculated weather normalized EUI in the Fort Collins benchmarking data. This is due to the analysis and weather normalization required to estimate end uses between the fuels and differing approaches. The analysis here is based on actual monthly utility data for 2022.



Assumed Energy Prices

Utility rate assumptions were provided by the City of Fort Collins

- Natural Gas: $0.79/ therm
- Electricity: $0.09/ kWh

While energy rates differ by service class and usage profile, these rates are assumed to represent the average costs for these types of buildings Fort Collins.

BPS EUI TARGET AND RECOMMENDED ENERGY EFFICIENCY MEASURES

Ulta's 2022 estimated EUI for the purpose of this study is 103 kBtu/ SF. This is 42% higher than the median performance of a Fort Collins Retail Store building of 60.2 kBtu/ SF.

The EUI target for Retail buildings is 49.5 kBtu/ SF.

This represents a 52% reduction in energy performance. As a result, a 25% cap on required energy reduction is calculated here to estimate the likely performance requirements for this building.

Recommended Measures

A summary table is below highlighting the recommended energy efficiency measures (EEMs). Costs are estimated to represent the total cost for equipment replacement. Where noted, incremental upgrade costs are calculated by comparing the difference in the upgrade cost as compared to a "business as usual" (BAU) replacement. These costs do not include estimated incentives.

#	Measure	EUI Savings (%)	Cost Savings ($/yr)	Measure Cost ($)	Simple Payback (Years)
1	Retro-Commissioning	5.2%	$1,200	$3,500	2.9
2	Heating Electrification	13.5%	$508	$32,500	63.9
3	Enhanced Process & Plug Load Management	3.0%	$848	$6,000	7.1
4	LED Lighting Upgrades	3.4%	$964	$1,900	2.0
Total		**25%**	**$3,520**	**$43,900**	**12.5**
Cost/ SF		**$4.36**			

* Heating Electrification calculated as incremental cost as compared to BAU. See description below

Resulting EUI

Value	Heating - Gas	Cooling - Gas	DHW - Gas	Baseload - Gas	Heating - Elec	Cooling - Elec	DHW - Elec	Baseload - Elec	Lighting - Elec	Total EUI
Resulting EUI	0	0.0	4.0	0	3.1	10.9	0	48.6	10.6	**77.2**
Reduction	100%	0%	6%	0%	-200%	6%	0%	12%	-25%	**25%**

Measure Descriptions

The purpose of the package of measures is to identify load reduction and energy efficiency measures to meet its respective target.

Fossil fuel equipment replacement is avoided as it can carry 15-20 year lifespans which may not meet future, stronger energy efficiency or GHG-reduction targets prior to EUL.

Heating and DHW system electrification is only recommended where it may present a relatively cost-effective opportunity based on site conditions, or no other feasible path is present. Electrification of heating or DHW will almost certainly enable most buildings to meet the target. The intent of this study and prospective targets, however, is to identify improvement of existing systems, including those that require fossil fuels.

Retro-Commissioning

Retro-commissioning (RCx) is the process of ensuring systems are designed, installed, functionally tested, and capable of being operated and maintained according to the owner's operational needs. It is a crucial process for maintaining existing building performance and is generally recognized as the first stage in the building upgrade process. Starting a staged upgrade approach with RCx accounts for interaction among energy flows within a building and ensures a systematic method to target the greatest possible energy savings. This process is always site-specific but is an effective real-world intervention.

Industry research estimates whole building energy savings can range widely from 5% to 30%. The RCx scope of work can vary widely depending on the needs of a building and available budget. Buildings where the existing building automation system (BAS) had more visibility into terminal equipment is assumed to have a higher percentage savings.

In the case of Ulta, energy uses can be significantly reduced through calibration and adjustment to the existing BAS.

Heating Electrification

Ulta is already planning to replace its four gas-fired RTUs with more efficient models in 2024.

Viewing the marginal cost of an electric heat pump alternative with gas backup is deemed appropriate as this replacement is already scheduled. Especially as this improved equipment is estimated to have relatively similar capital costs to purchasing new gas-fired equipment.

- BAU cost: the cost of installing another gas-fired unit is estimated at $234,500.
- High-performance alternative: the cost of installing an electric heat pump with gas backup is estimated at $267,000.
- The marginal cost difference displayed here is $32,500.

Enhanced Process & Plug Load Management

As noted, electrical plug loads are the largest end use in the property. Every appliance and piece of equipment connected to an outlet draws electricity which may not be monitored. Multiple approaches to reducing loads could be applied such as replacement with ENERGY STAR labeled equipment where available, occupancy sensors to enable zoning and equipment shut down, power management settings on computers and other equipment, instituting standby mode on equipment, and power management surge protectors.

There may be constraints in plug load management for retail that is part of a national chain. However this study identifies the necessary reductions needed to achieve the EUI target, which are within the expected bounds of estimated savings.

LED Lighting Upgrade

Interior lighting is primarily non-LED and scheduled for an upgrade in 2024. Full LED replacement of existing fixtures, coupled with appropriate scheduling, will result in substantial savings for assumed lighting energy use.

Measures Reviewed but Not Recommended

Multiple measures were reviewed but not included in this study:

Roof Replacement

A high-performance roof assembly with increased insulation values and resurfacing and reduce heating and cooling loads due to the large ratio of roof area to building square footage. Roof insulation replacement values are estimated with a U-Value of 0.30.

As the contact for the case study does not have direct control over the roof assembly, projections were run focusing on those measures within Ulta's control. Roof insulation is modeled to save roughly 4% of site energy with an estimated cost of roughly $150,000. Less cost intensive measures were considered.

BUILDING DESKTOP AUDITS

Case studies were developed through interviews with building managers and site staff to collect – for major equipment only – equipment type, equipment age, operating parameters, types of fuel used for various end uses, information on recent capital upgrades, and any comments on plans for future upgrades and decision-making processes in relation to energy management. Architectural and mechanical drawings and supporting documentation were reviewed when available.

Desktop audits were performed in order to develop the case studies contained in this report. Desktop audits use information provided from building owners and operators to develop recommendations, but do not contain any onsite observations. This methodology is effective for informing policy-level decisions as it can effectively capture broad-stroke approaches; however, this methodology does not tend to capture measures that are more limited in impact (e.g., mechanical systems that only serve part of the building). Applicability of desktop audit measures to a specific building typically requires some amount of onsite investigation in order to determine applicability of measures for any specific building in a given typology. This technical analysis is limited to desktop audits and measure recommendations are limited to what could be recommended based on the data collected by the auditor.

Where possible, supplemental energy audit information performed by others is incorporated into the case studies. These energy audits, which may contain onsite observations, were completed prior to this desktop audit process.