LL97 Multifamily Studies

561 10th Avenue “The Victory”
345 East 94th Street “The Chesapeake”
298 Mulberry

November 8th, 2023
REV 00

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  - ECM Phasing and Packaging
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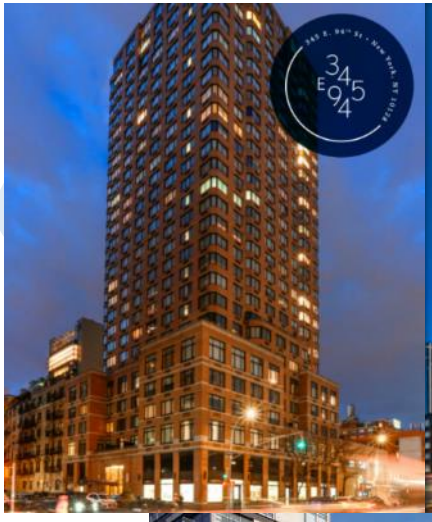
345 E94th St



561 10th Avenue

298 Mulberry

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ESRT 2.0 Building Retrofit Goals
Building Case Studies (Victory, Chesapeake, Mulberry)
- Baseline Energy Modeling
- ECM Phasing and Packaging
- Energy and Carbon Emissions Results
- Financial Analysis and Recommendations
- Capital Expenditure and Budget

Lessons Learned
Appendix

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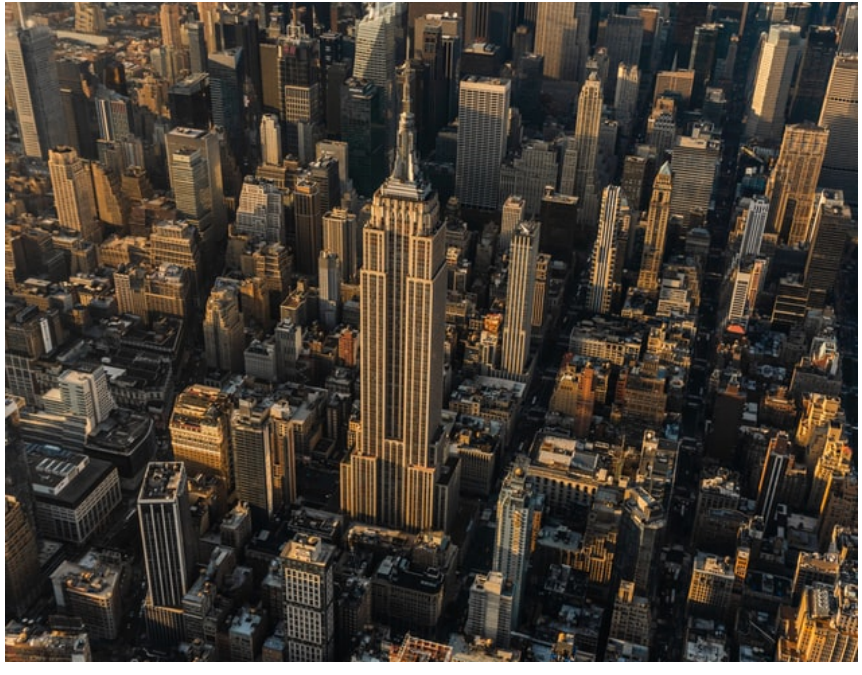
ESRT 2.0 - LL97 Deep Energy Retrofit Goals

- Evaluate the technical and economic potential to achieve carbon neutrality
- Define technical and economic needs to meet and exceed State and City targets and plans for 2024, 2030, 2035, 2050
- Evaluate the effects of different grid commitments
- Conduct a thorough technology review via pilots, building tests, energy modeling, site visits and vendor evaluations
- Analyze whole system approach based on energy models, economic assessment and supply side opportunities
- Utilize private know-how, leadership and public funding
- Utilize multi-stakeholder engagement which thoroughly explores the role of tenants to meet targets



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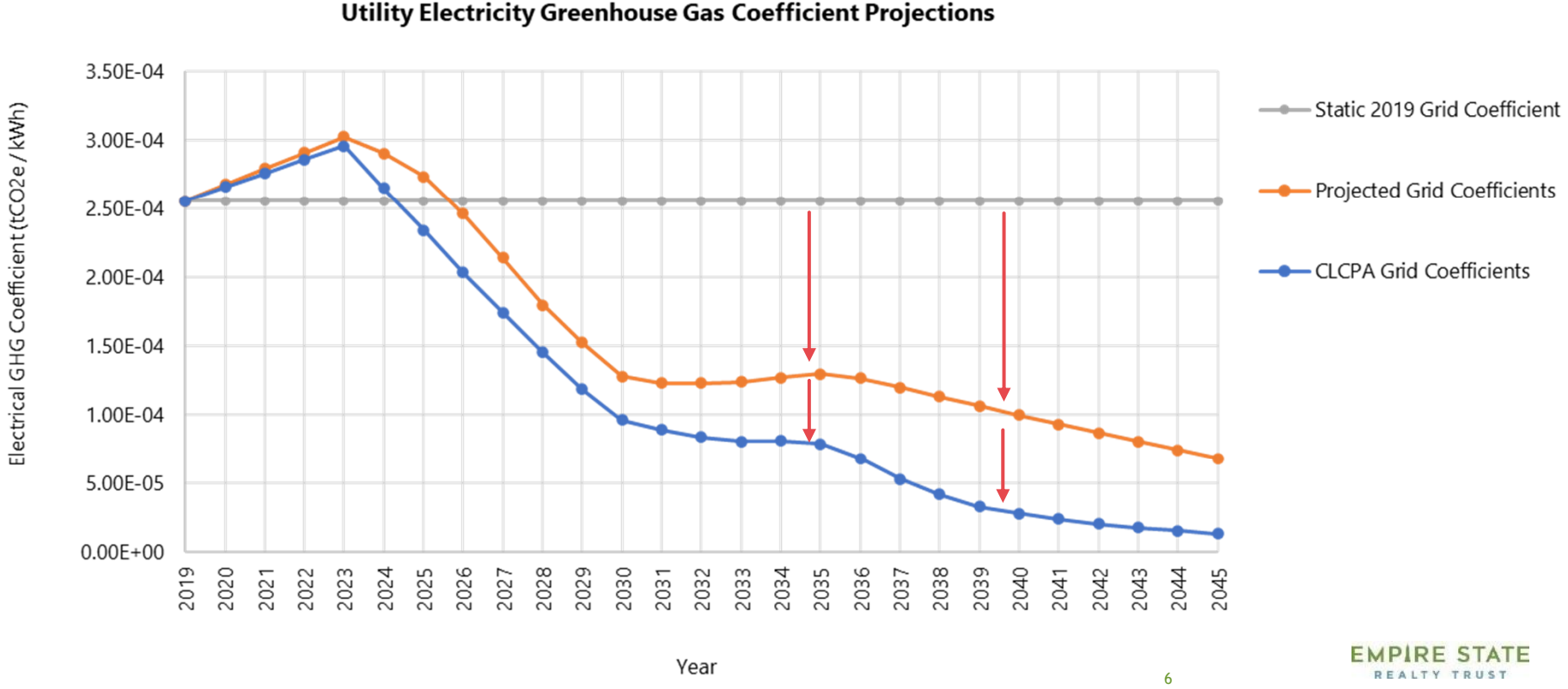
Defining Net-Zero Carbon

ESRT's definition of net zero for existing buildings is that by extreme reduction of building operational emissions, partnership with a renewably sourced grid aligned with the CLCPA, and strategic offsets of residual emissions through clean energy generation and accredited initiatives, net annual building operational carbon emissions are equal to zero.

By 2030 for the Empire State Building and **by 2035 for the commercial portfolio**, ESRT will target net zero carbon emissions through **an 80% operational carbon emissions reduction** — to be achieved through a combination of energy efficiency measures and a more renewably sourced grid — and a 20% offset through verified renewable energy and conservation projects.

Grid Projections: CLCPA Grid Scenario vs. Projected Grid Scenario

Static Grid – 2019 electricity GHG coefficient
Projected Grid – projected electricity GHG coefficients
CLCPA Grid – electricity GHG coefficients in alignment with the NYS Climate Act (CLCPA)



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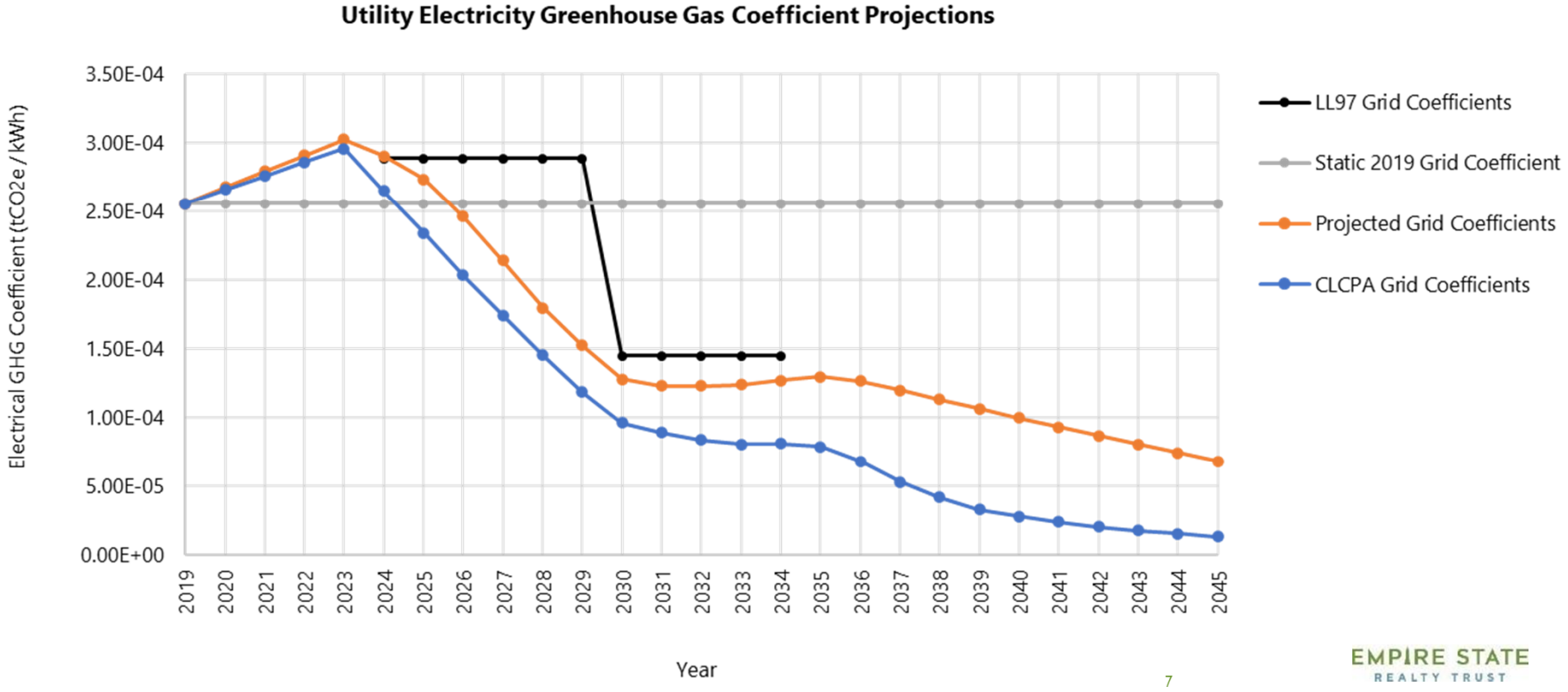
Grid Projections: LL97 Grid Emissions (2024-2034)

LL97 Grid - electricity GHG coefficients for 2024-2029 and 2030-2034 provided in LL97 of 2019 and 2022 proposed rules



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The Victory Case Study

Baseline Energy Modeling
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The Victory - Current Building Systems

- Built in 2004, 45 stories, 417 units,
- 309,331 SF: 296,856 SF Residential, 12,475 SF Retail
- Boilers
  - 16,330MBH dual fuel fire-tube low pressure steam boilers
  - Original to the building, 19 years old
  - Serves building heat and domestic hot water
- Apartment heating/cooling
  - Air-cooled PTAC units with steam coil
- Common building spaces and retail space served by DX units with steam heating coils and AHUs

2019 Energy Breakdown by Utility

2019 Building Energy Utilization Index = 100.73 kBtu/SF/year

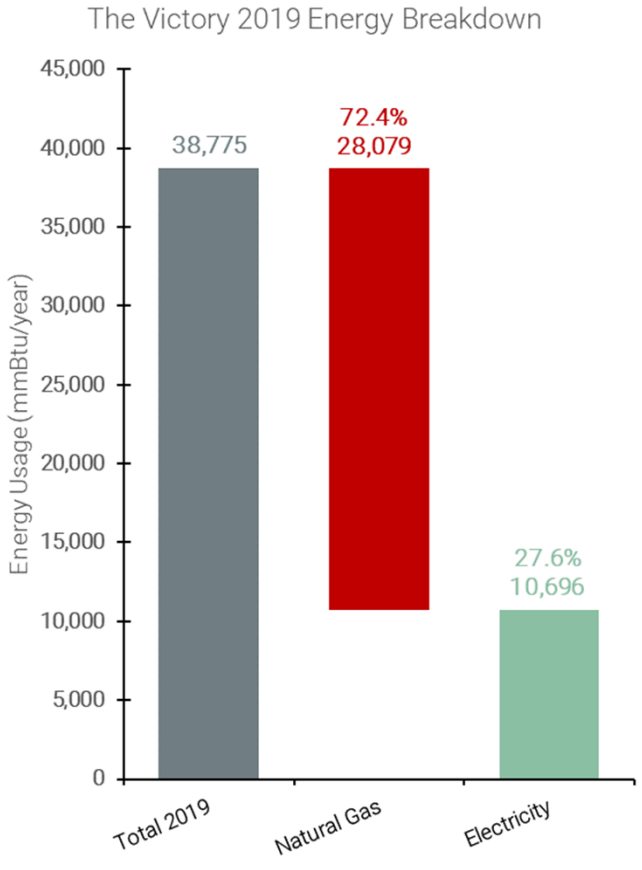
Electricity

- 27.6% of energy usage
- 34.5% of CO_2e emissions

Fossil Fuels

- 72.4% of energy usage
- 65.5% of CO_2e emissions

Year	Electricity (kWh/year)	Fossil Fuel (therms/year)	EUI (kBtu/SF)
2018	3,202,655	296,677	105.01
2019	3,134,077	282,485	100.73
2020	2,936,090	209,733	80.16
2021	2,874,715	211,207	80.00



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2019 CO_2e Emissions Breakdown by Utility

Carbon Intensity vs. Energy Intensity

Electricity

- 34.5% of CO_2e emissions
- 37.6% of energy usage

Fossil Fuel

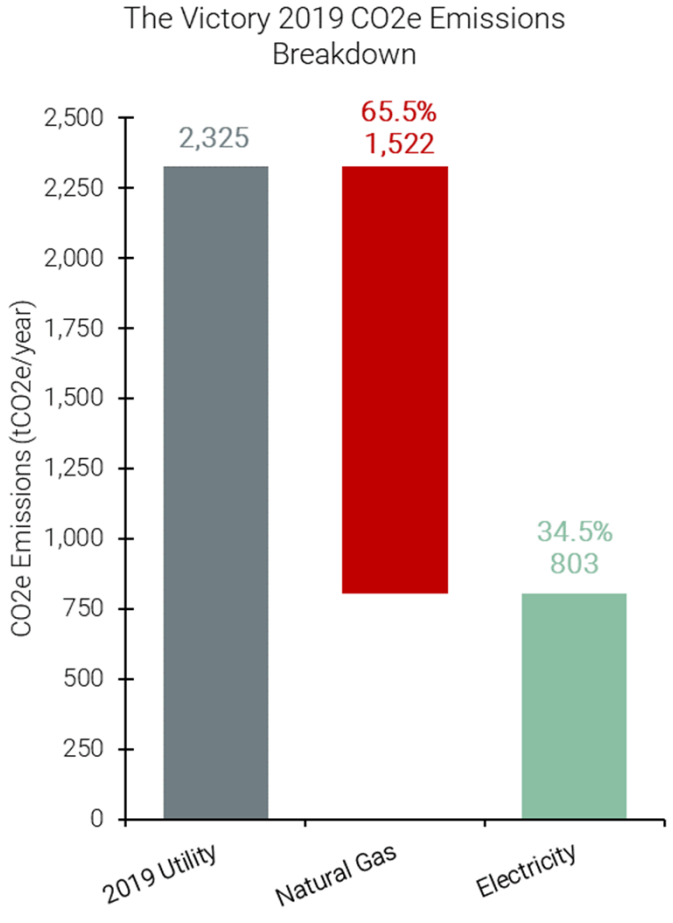
- 65.5% of CO_2e emissions
- 72.4% of energy usage

2019 Electricity – 256.0 tCO_2e/GWh (Luthin)

2022 Electricity – 286.0 tCO_2e/GWh (Luthin)

Fuel Oil #2 – 253.21 tCO_2e/GWh (LL97)

Natural Gas – 181.22 tCO_2e/GWh (LL97)



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2019 Operational Cost Breakdown by Utility

Fossil Fuel vs Electricity Operational Costs

Estimated 2019 utility operational cost = $917,256

Electricity

- 70.6% of operational costs
- 27.6% of energy usage

Fossil Fuel

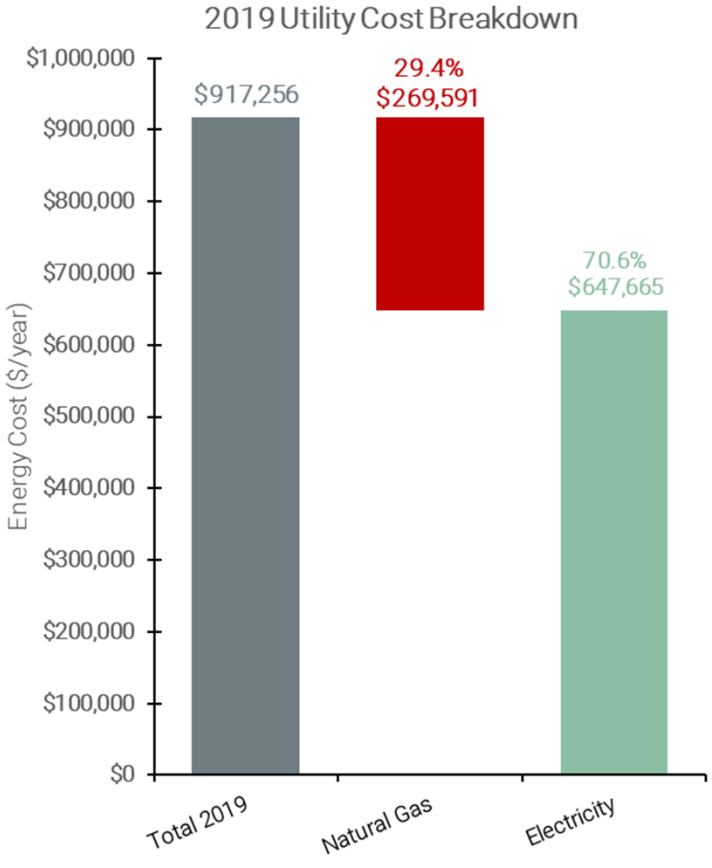
- 29.4% of operational costs
- 72.4% of energy usage

Blended Utility Rates (estimated)

Natural Gas = $0.95/therm = **$0.009/kBtu**

BB Electricity = $0.18/kWh = **$0.053/kBtu**

Res Electricity = $0.23/kWh = **$0.067/kBtu**



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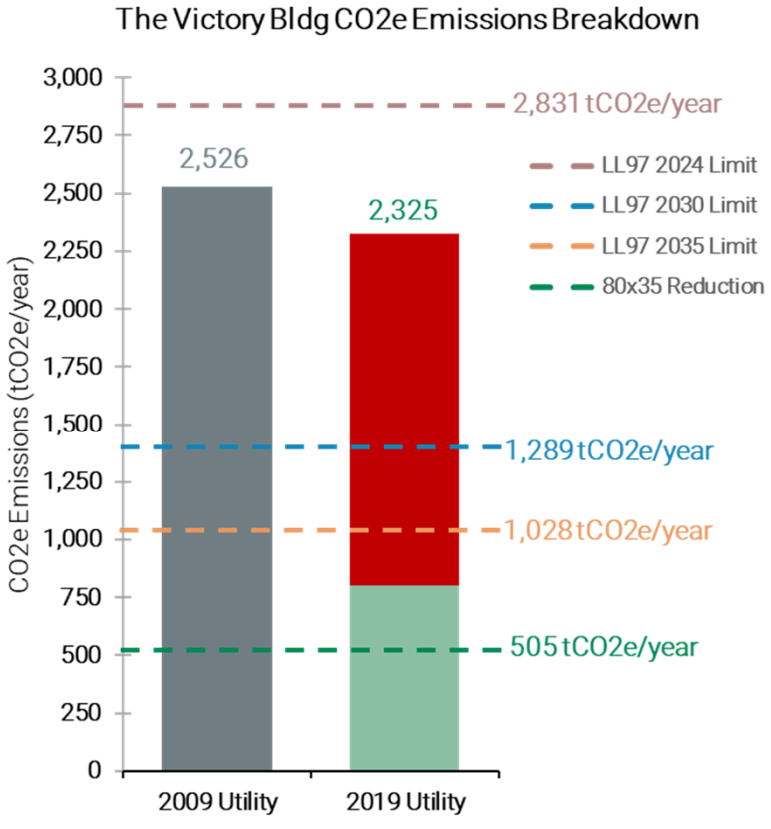
The Victory Current Status for LL97 and 80x35 Challenge



Key Takeaways:

- Building meets 2024 Limit of 2,831 tCO_2e/year
- 44.6% reduction is required to meet LL97 2030 target of 1,289 tCO_2e/year
- 55.6% reduction is required to meet LL97 2035 target of 1,028 tCO_2e/year
- 78.3% reduction is required to meet ESRT 80x35 goal

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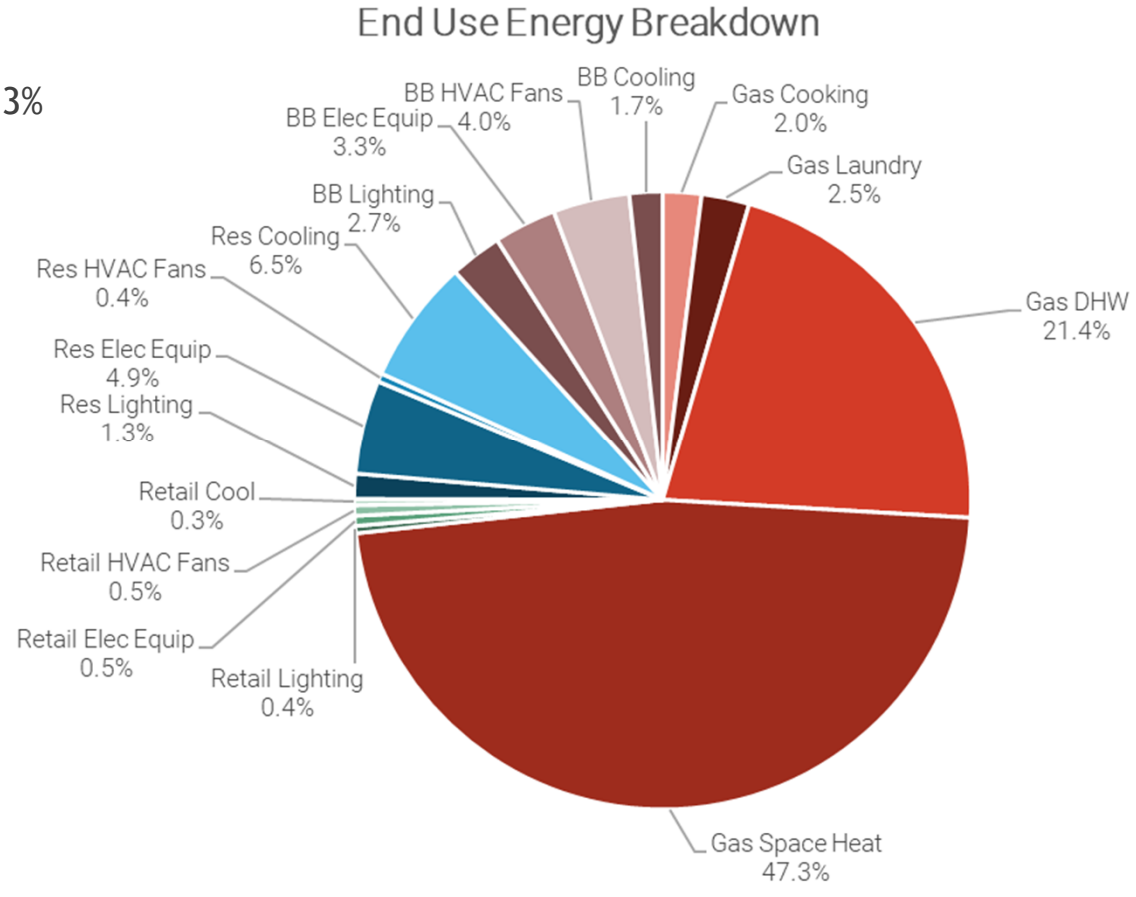
The Victory Energy Model: 2019 Energy Breakdown

Analyzes major end-uses and highlight opportunities for improvement

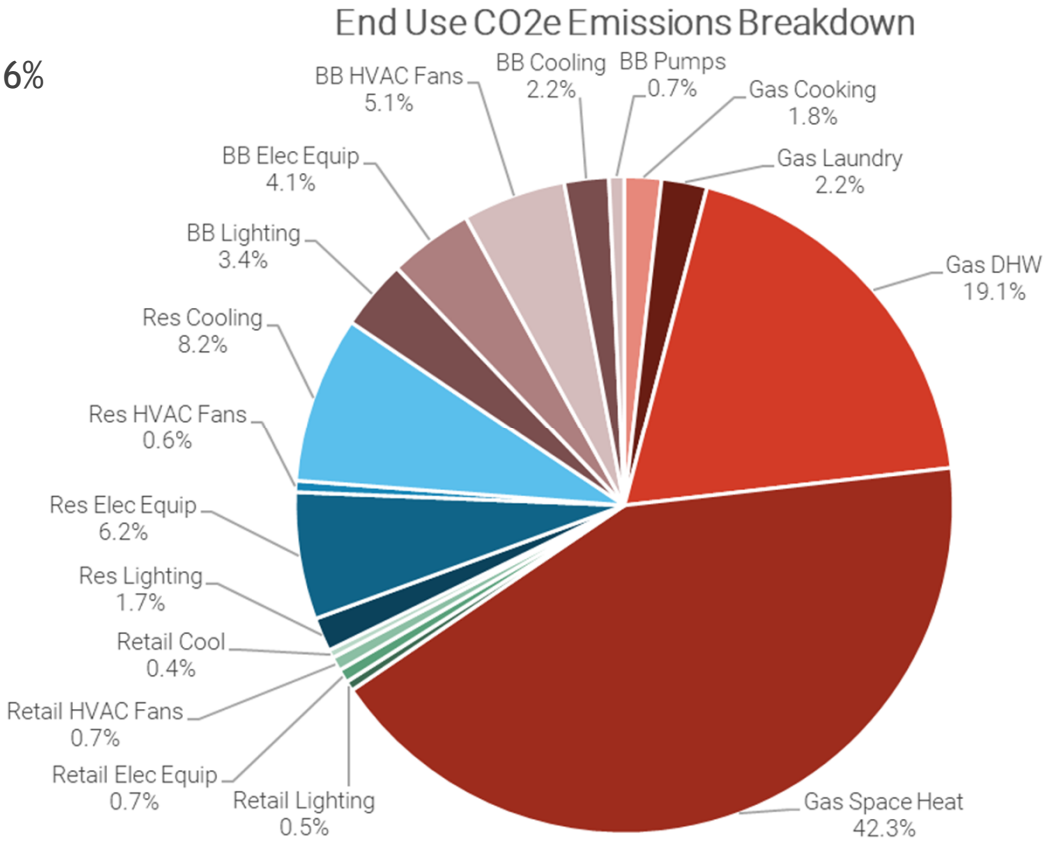
- Residential Tenants ~17.7%
- Base Building Electricity 12.3%
- Space Heating 47.1%
- DHW 21.3%
- Retail Tenants ~1.8%



The Victory Energy Model: 2019 CO_2e Emissions Breakdown

Analyzes major end-uses and highlight opportunities for improvement

- Residential Tenants ~20.8%
- Base Building Electricity 15.6%
- Space Heating 42.3%
- DHW 19.1%
- Retail Tenants ~2.2%



The Victory Case Study

Baseline Energy Modeling
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ECM Packages - Recommended Package is CO_2 Mid

Four packages of ECMs were developed to optimize NPV and CO_2 reductions

1	2	3	4
			
CO_2 Light Space Heat Partial Electrification: PTHP for Apartment Heat and VRF for Common Areas	**CO_2 Mid** Space Heat Full Electrification and ERV Domestic Hot Water Heating Electrification - 80%	**CO_2 High** Space Heat Full Electrification and ERV Domestic Hot Water Heating Electrification - 95%	**CO_2 Max** Space Heat Full Electrification and ERV Domestic Hot Water Heating Electrification - 100%

Carbon Reduction

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ECM Phases & Implementation Timeline: CO_2 Mid

ENERGY CONSERVATION MEASURES (ECMS)			IMPLEMENTATION TIMELINE											
Phase	**Tag**	**Short Name**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**
Phase 1	DW002	Reduce laundry hot water temperatures	0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Phase 1	DW003	Domestic cold water pumping optimization	0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Phase 1	CO002	Demand controlled ventilation	0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Phase 1	CO003	VFD CO/NO2 Control for Garage Exhaust	0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Phase 1	AS003	Replace rooftop exhaust fans not connected to ERV; Including nighttime setback vent rate.	0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Phase 1	EN006	Garage Entrance Roll-Up Door	0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Phase 1	VT001	EMR conditioning	0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Phase 2	SS001	Optimization for peak heating demand periods	0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Phase 2	EL001	Change all AC to Heat Pumps in Amenity Spaces	0%	0%	0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Phase 2	AS001	Energy Recovery Replacement	0%	0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Phase 2	EL006	Domestic Water Heat Pump Semi-Partial Electrification	0%	0%	0%	0%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Phase 3	DW001	Replace Showerheads with Low GPM Fixture	0%	25%	50%	75%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Phase 3	TL002	Energy Efficient Appliances	0%	9%	18%	27%	36%	45%	55%	64%	73%	82%	91%	100%	100%
Phase 3	SS002	Flue gas economizer	0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Phase 3	AS005	Replace apartment PTAC AC units with PTHP	0%	9%	18%	27%	36%	45%	55%	64%	73%	82%	91%	100%	100%
Phase 3	TL005	Replace proposed Condensing Dryers with heat pump Washer/Dryer	0%	17%	33%	50%	67%	83%	100%	100%	100%	100%	100%	100%	100%
Phase 4	TL004	Central Wifi	0%	20%	40%	60%	80%	100%	100%	100%	100%	100%	100%	100%	100%

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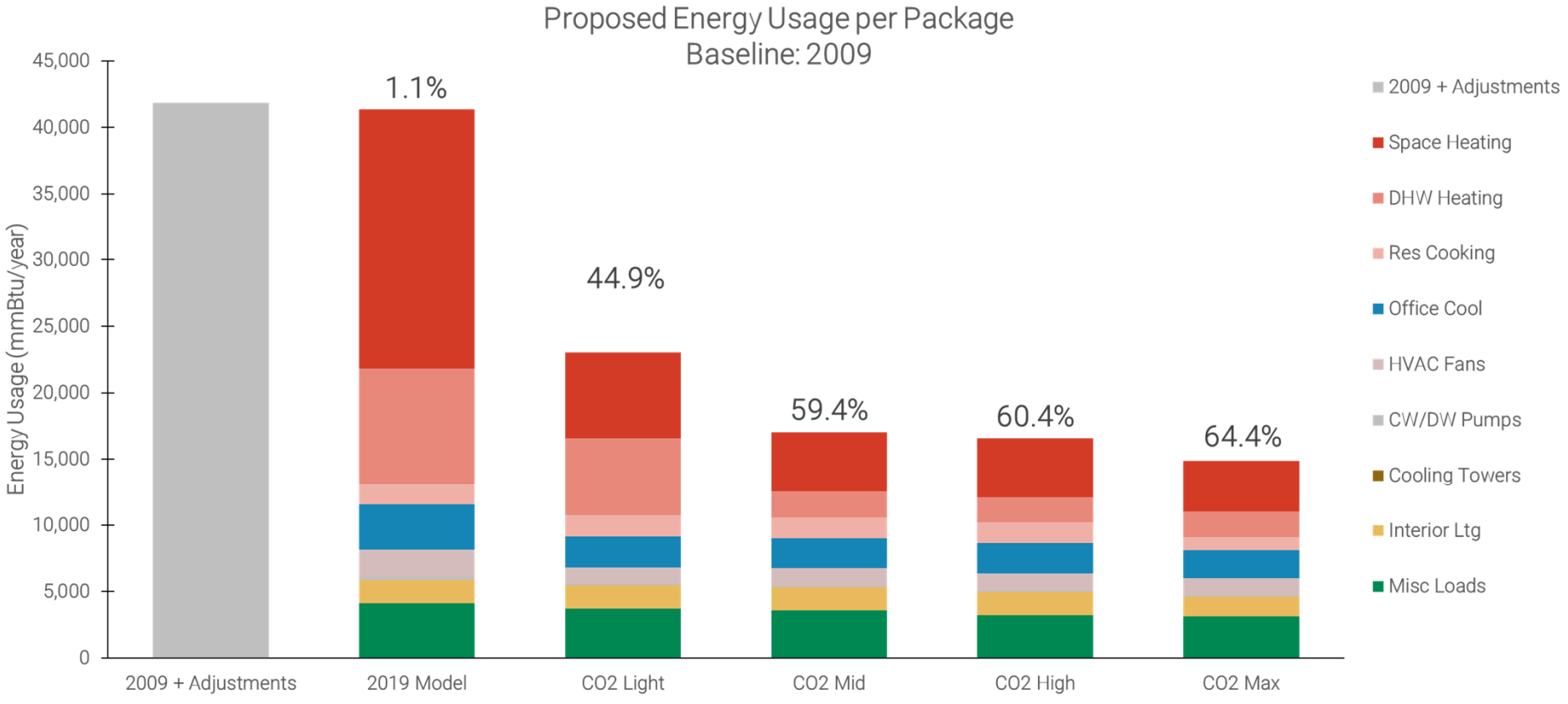
The Victory ECM Package Comparison: Energy

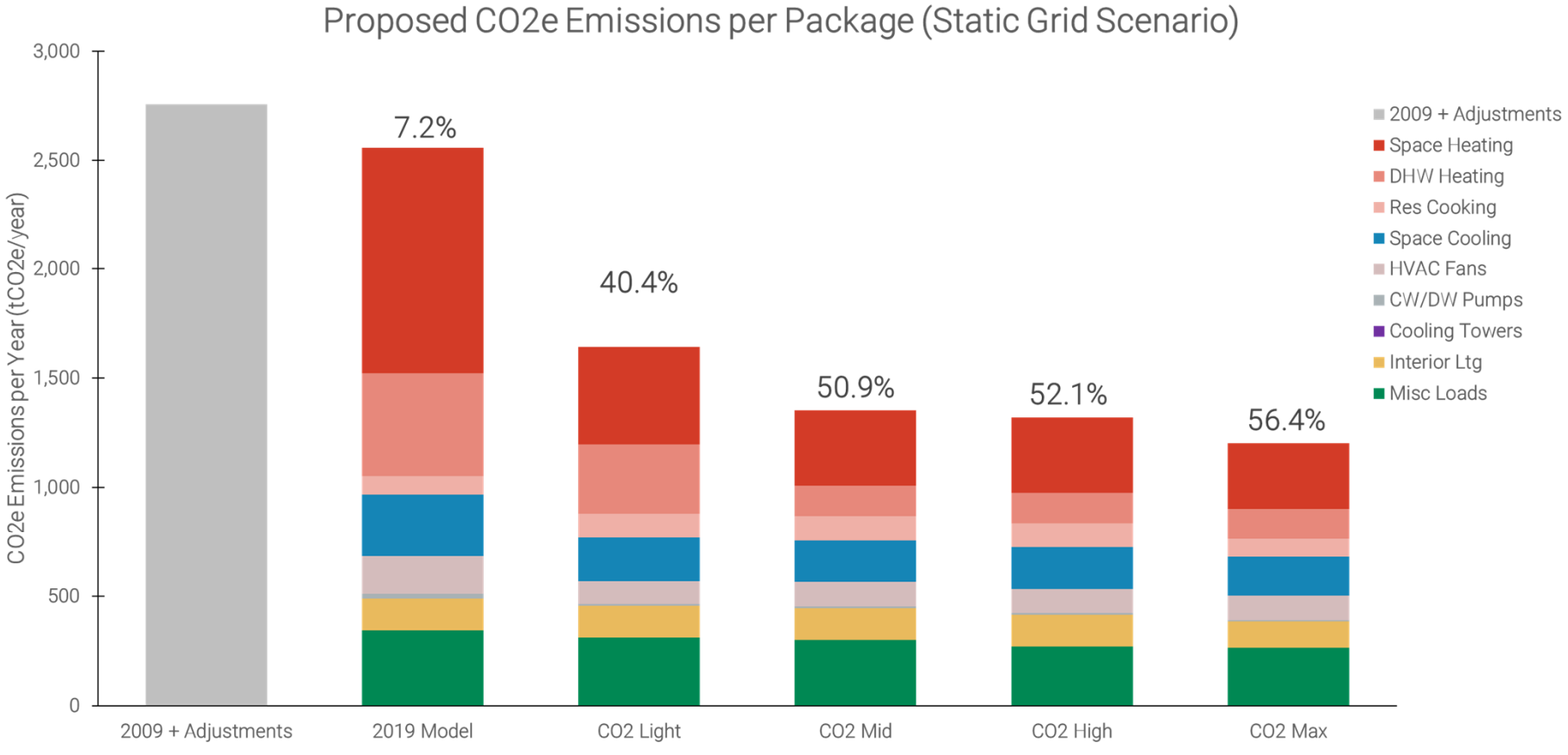
Baseline: 2019



Notes:
2009 + Adjustments are estimated from 2022 energy use with adjustments from building improvements (lighting)

Projected CO_2 Emissions: Static 2019 Grid Scenario

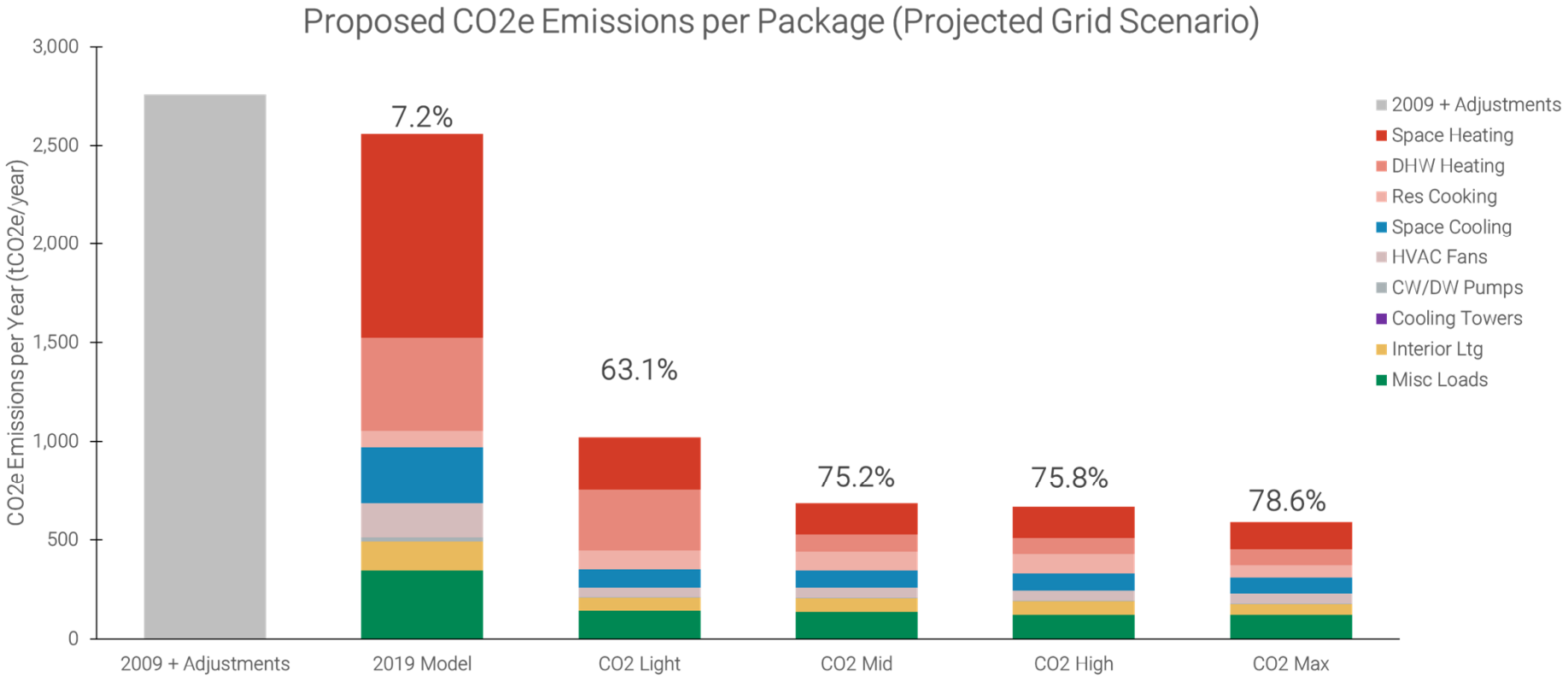
Baseline: 2019



Notes:
2009 + Adjustments are estimated from 2022 energy use with adjustments from building improvements (lighting) and with 2009 electricity grid factors

Projected CO_2 Emissions: Projected Grid Scenario

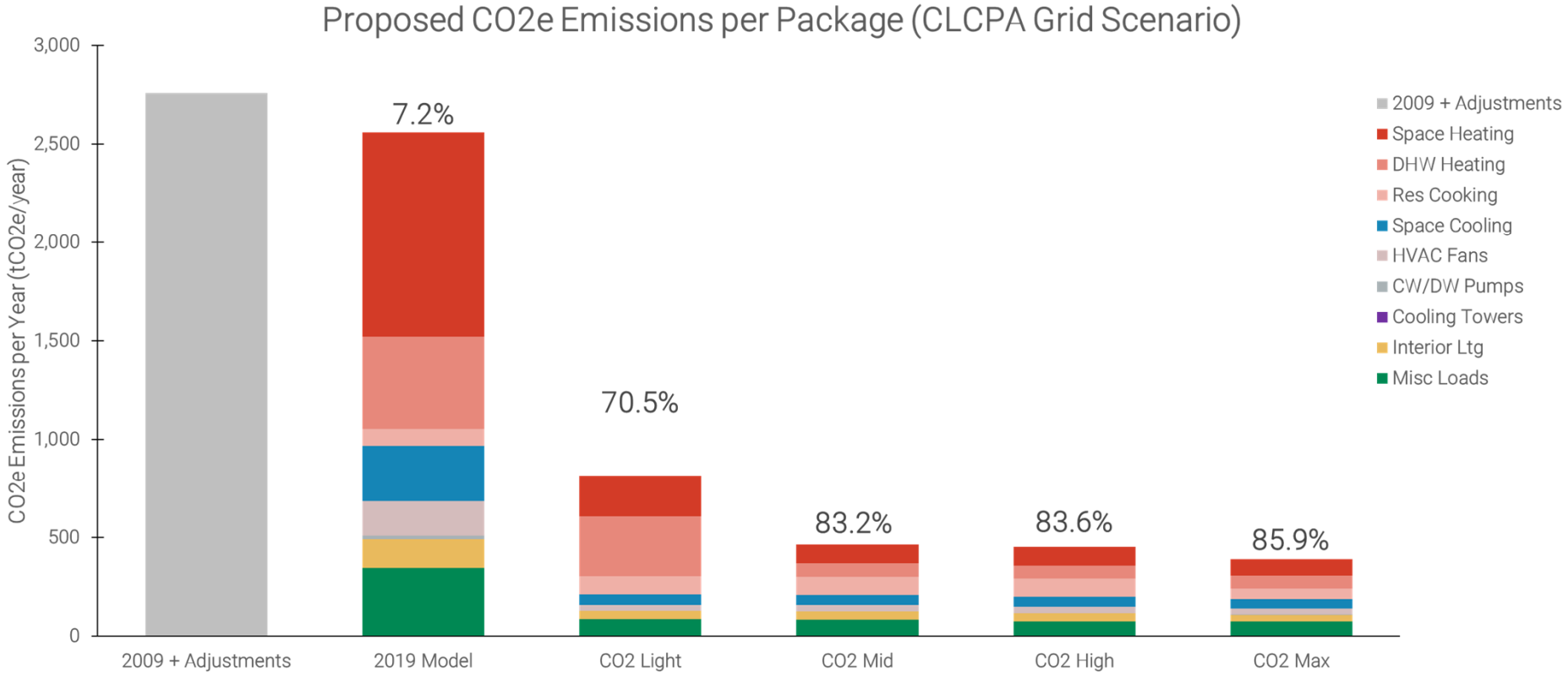
The graph shows projected emissions in 2035



Notes:
2009 + Adjustments are estimated from 2022 energy use with adjustments from building improvements (lighting) and with 2009 electricity grid factors

Projected CO_2 Emissions: CLCPA Grid Scenario

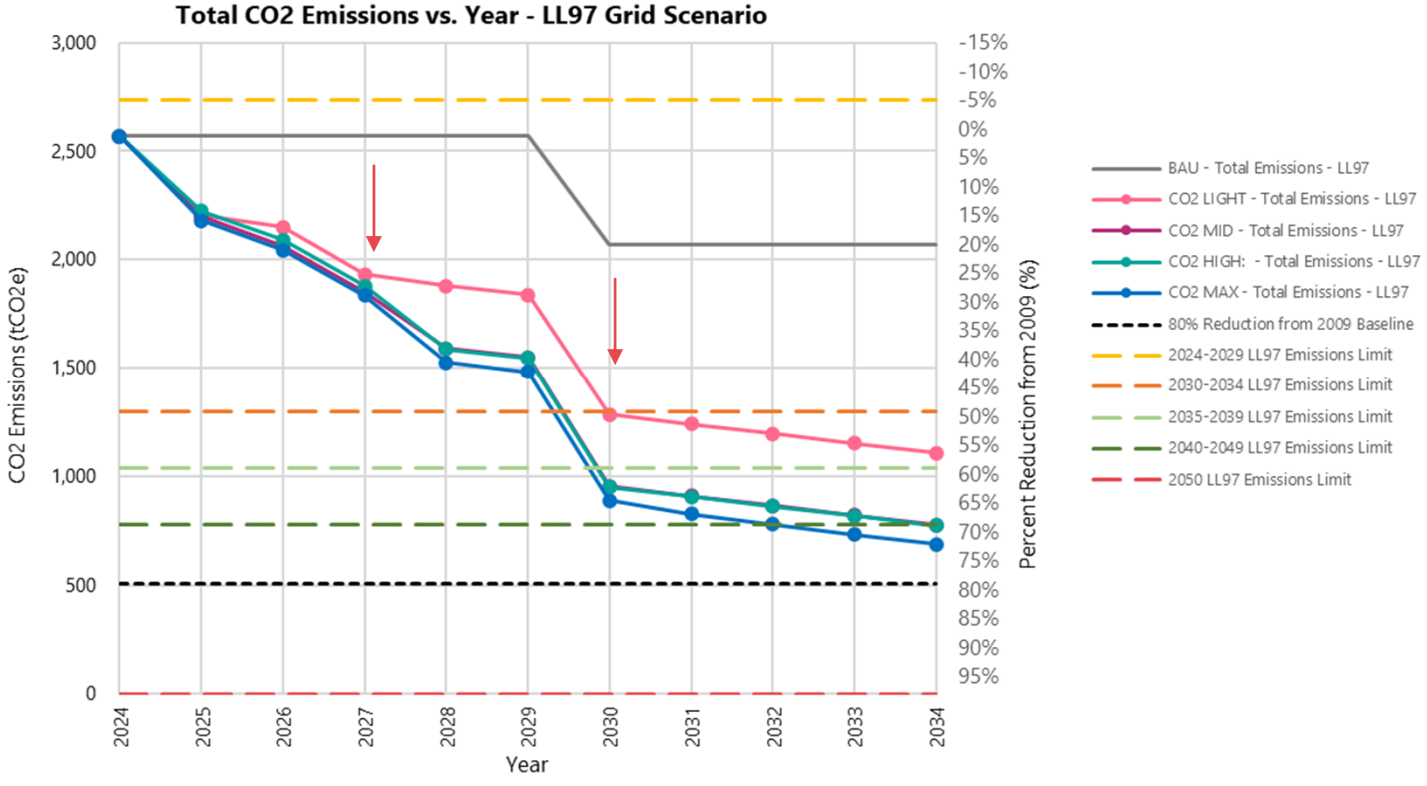
The graph shows projected emissions in 2035



Notes:
2009 + Adjustments are estimated from 2022 energy use with adjustments from building improvements (lighting) and with 2009 electricity grid factors

Projected Annual Carbon Emissions – LL97 Compliance

Current 2019 baseline & all packages are below 2024 LL97 emissions limits
CO2 Mid, High & Max are below 2030 and 2035 limits



1. 2035-2039 and 2040-2049 limits are shown for reference only. Compliance cannot be confirmed until GHG emissions coefficients for those periods are released.
2. 80% Reduction from 2009 Baseline are estimated from 2022 energy use to 2009 emission coefficients

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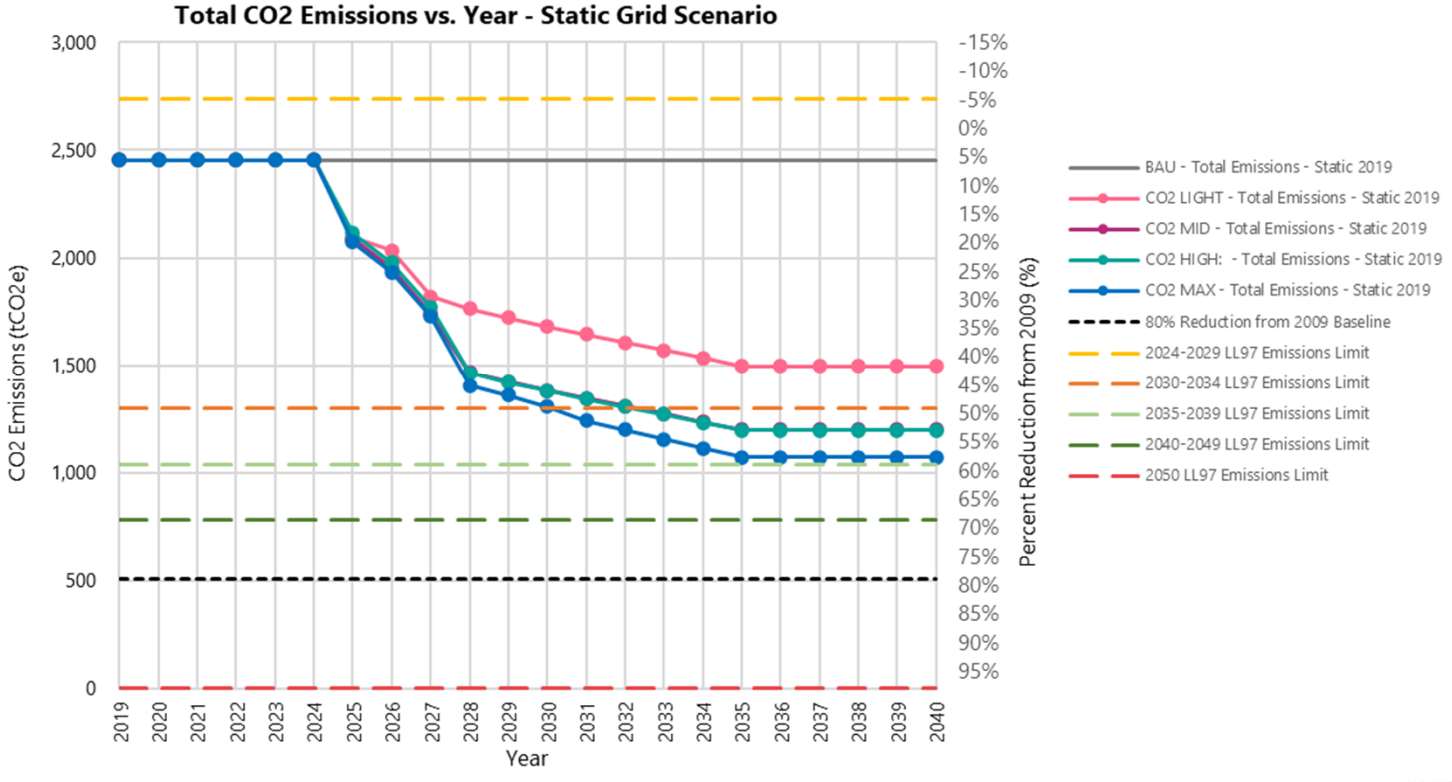
Projected Annual Carbon Emissions – Static 2019 Grid Scenario

No packages would meet **80% reduction** from 2009 baseline by **2035** without grid decarbonization;
No packages would meet **2040 -2049 LL97 Emissions Limit** without grid decarbonization



1. 2035-2039 and 2040-2049 limits are shown for reference only. Compliance cannot be confirmed until GHG emissions coefficients for those periods are released.
2. 80% Reduction from 2009 Baseline are estimated from 2022 energy use to 2009 emission coefficients

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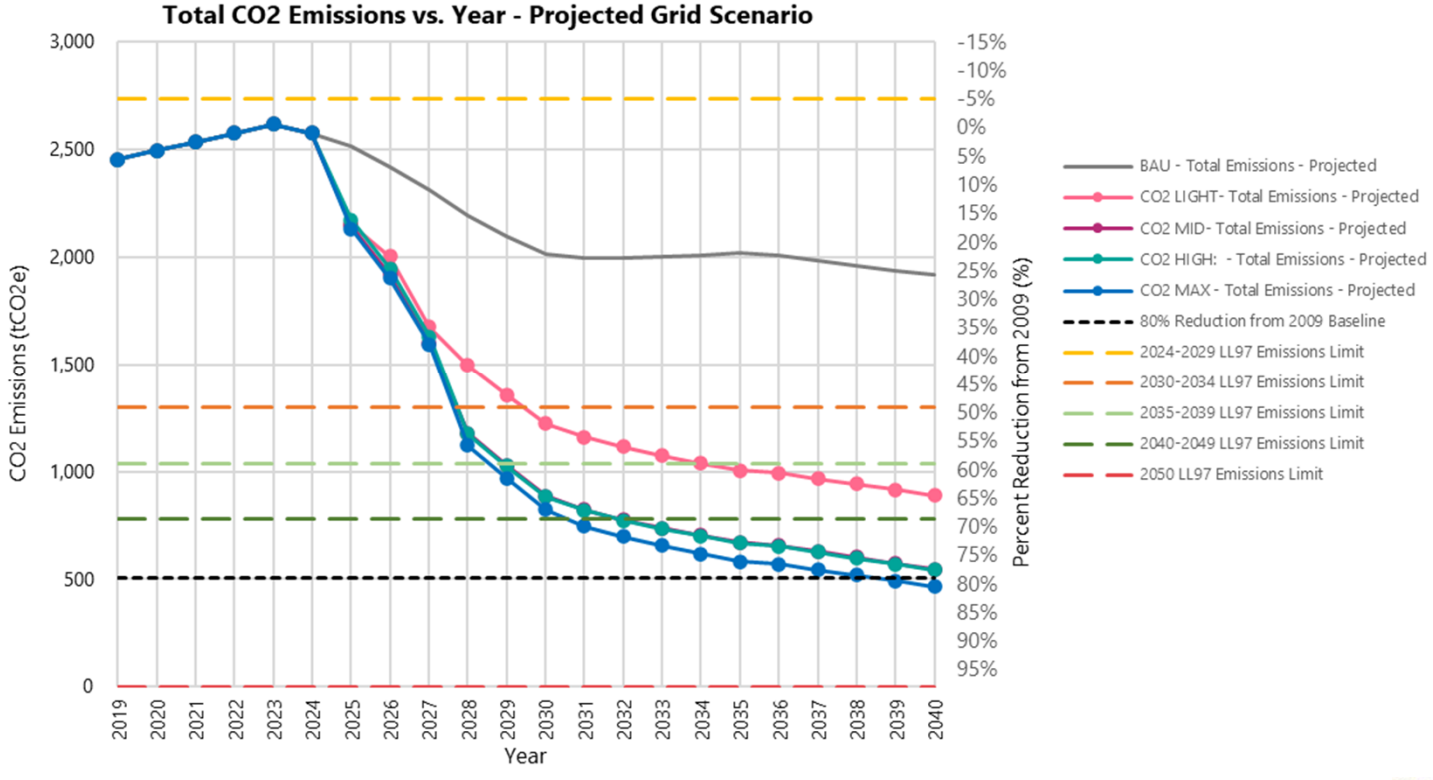
Projected Annual Carbon Emissions – Projected Grid Scenario

No packages would meet **80% reduction** from 2009 baseline by **2035**;
CO2 Mid, High, and Max meet **2040 -2049 LL97 Emissions Limit**



1. 2035-2039 and 2040-2049 limits are shown for reference only. Compliance cannot be confirmed until GHG emissions coefficients for those periods are released.
2. 80% Reduction from 2009 Baseline are estimated from 2022 energy use to 2009 emission coefficients

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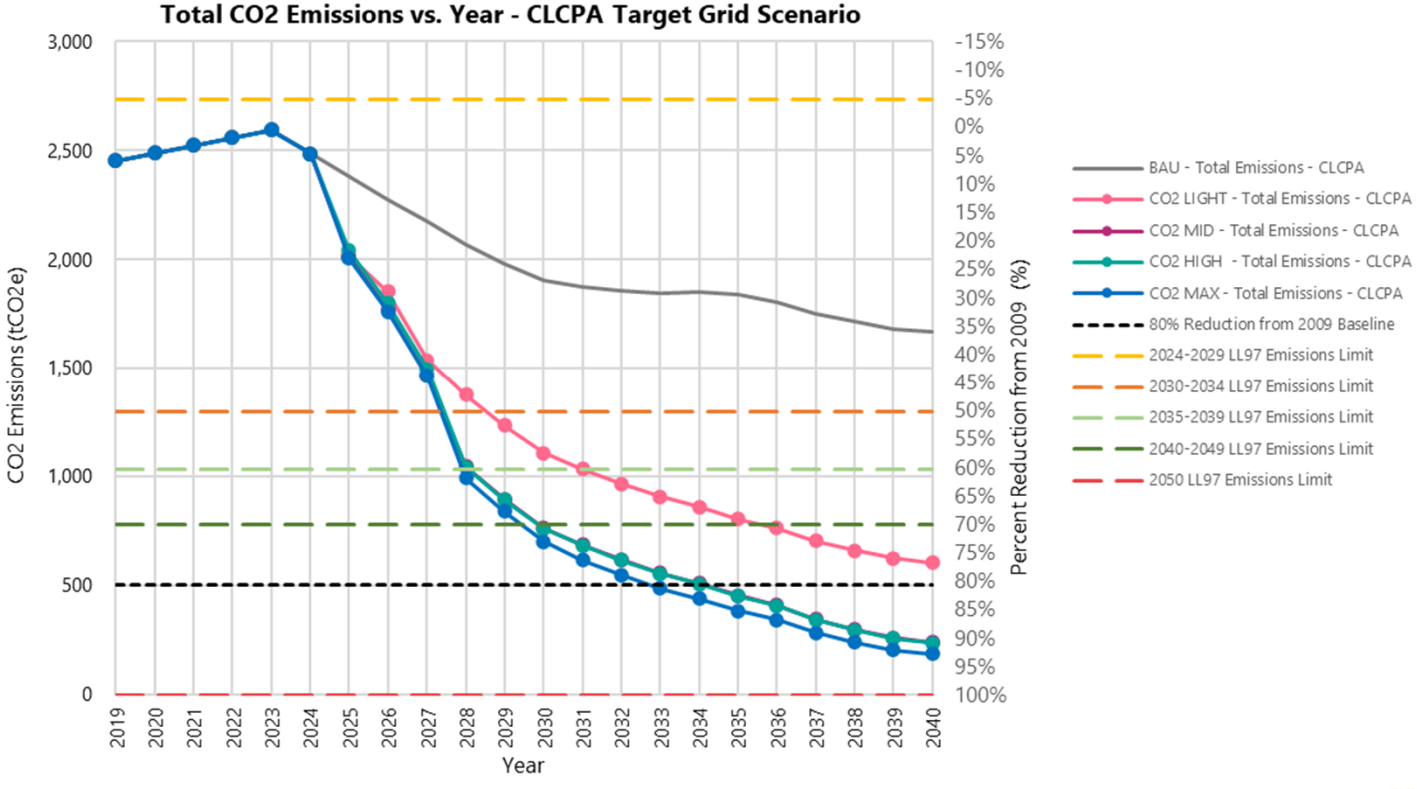
Projected Annual Carbon Emissions – CLCPA Grid Scenario

CO_2 Mid, High and Max meet **80% reduction** from 2009 baseline by **2035**;
All packages would meet **2040 -2049 LL97 Emissions Limit**



1. 2035-2039 and 2040-2049 limits are shown for reference only. Compliance cannot be confirmed until GHG emissions coefficients for those periods are released.
2. 80% Reduction from 2009 Baseline are estimated from 2022 energy use to 2009 emission coefficients

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Percent Carbon Emissions Reductions – All Grid Scenarios

80x35 target based on reductions from 2009 baseline
Reductions from 2019 baseline show impact of packages compared to current usage

STATIC GRID SCENARIO

	2019 - 2030	2019 - 2035	**2009 - 2030**	**2009 - 2035**
CO2 MAX	-46.7%	-56.4%	**-48.2%**	**-57.6%**
CO2 HIGH	-43.8%	-51.3%	**-45.4%**	**-52.7%**
CO2 MID	-43.7%	-51.2%	**-45.3%**	**-52.5%**
CO2 LIGHT	-31.5%	-39.0%	**-33.5%**	**-40.7%**

No packages would meet **80% reduction** from 2009 baseline by **2035** or the **2035 LL97 emission limit**

PROJECTED GRID SCENARIO

	2019 - 2030	2019 - 2035	**2009 - 2030**	**2009 - 2035**
CO2 MAX	-66.5%	-76.3%	**-67.4%**	**-76.9%**
CO2 HIGH	-64.0%	-72.8%	**-65.0%**	**-73.6%**
CO2 MID	-63.9%	-72.7%	**-64.9%**	**-73.5%**
CO2 LIGHT	-50.2%	-59.0%	**-51.6%**	**-60.2%**

No packages would meet **80% reduction** from 2009 baseline by **2035**;
All packages except CO_2 Light would meet the **2035 LL97 emission limit**

CLCPA TARGET GRID SCENARIO

	2019 - 2030	2019 - 2035	**2009 - 2030**	**2009 - 2035**
CO2 MAX	-71.3%	-84.3%	**-72.1%**	**-84.8%**
CO2 HIGH	-69.0%	-81.6%	**-69.9%**	**-82.1%**
CO2 MID	-68.9%	-81.4%	**-69.7%**	**-81.9%**
CO2 LIGHT	-54.8%	-67.2%	**-56.1%**	**-68.1%**

All packages except CO_2 Light would meet **80% reduction** from 2009 baseline by **2035**;
All packages would meet the **2035 LL97 emission limit**

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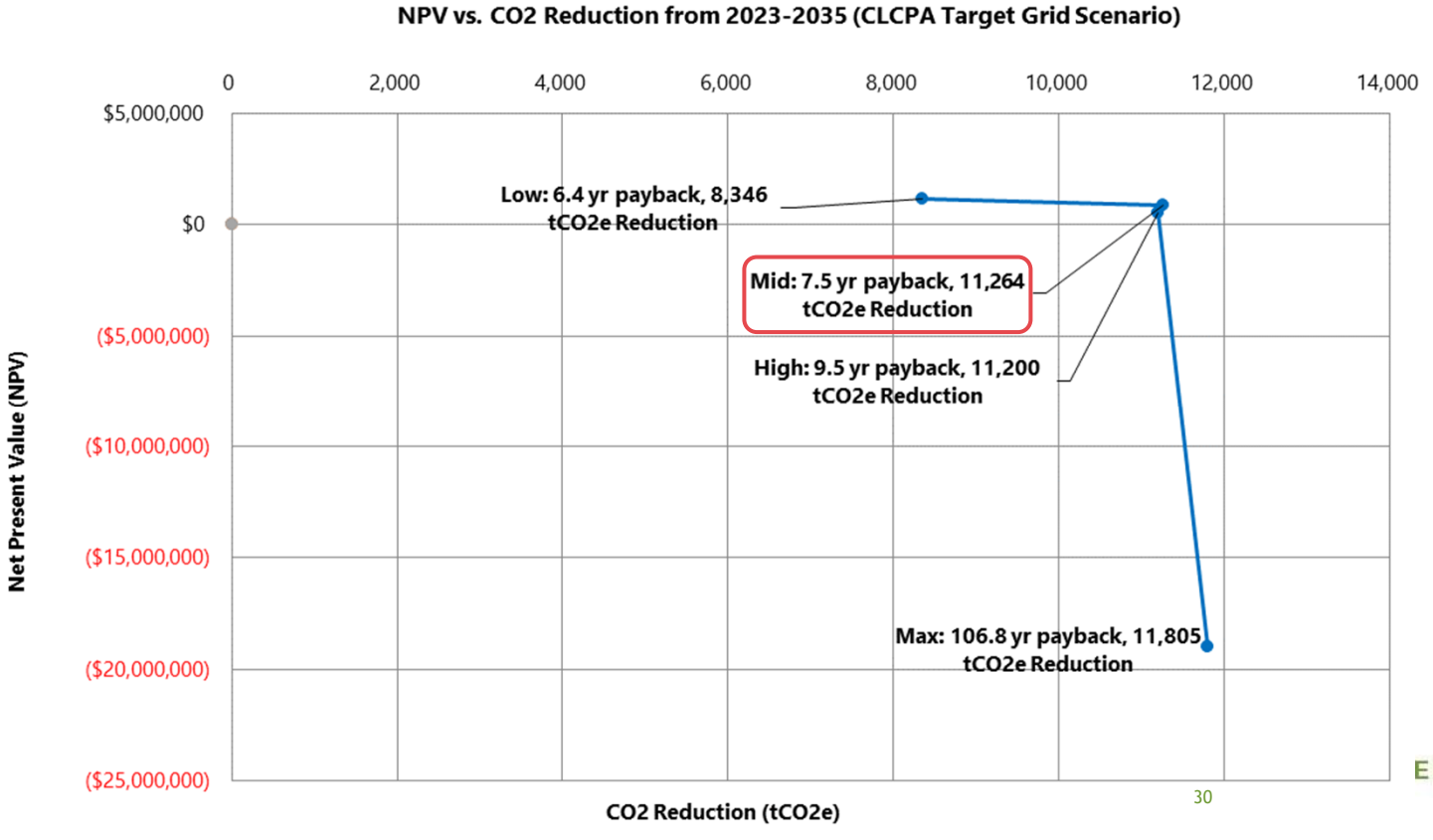
NPV, CO_2 Reductions and Simple Payback for all Packages

Recommended package CO_2 Mid is NPV positive from 2023-2035 and provides 35% greater carbon emissions reduction over study period compared to CO_2 Light



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NPV calculated with 6% real discount rate

Projected LL97 Fines From 2024-2034

No LL97 fines projected for the baseline for 2024-2029;
Fines possible from 2030-2034 for baseline, all packages offset the potential fines.

Packages	LL97 Fines From 2024-2034		
	LL97 of 2022 Emissions Limits		
	Total Fine From 2024-2029	Total Fine From 2030-2034	Fine Avoidance From 2024-2034
BAU (2019 Consumption)	$0	$1,036,384	-
Low	$0	$0	$1,036,384
Mid	$0	$0	$1,036,384
High	$0	$0	$1,036,384
Max	$0	$0	$1,036,384

1. 2022 emissions limits are calculated using the building emissions factors provided in the LL97 rules, which are based on Energy Star property types.
2. Fine calculations for 2024-2029 and 2030-2034 are based on GHG coefficients provided in LL97 of 2022.

Projected LL97 Fines From 2035-2050 Based on Projected Grid Scenario

Fines projected for the baseline and low package, though all packages offset the fines

Packages	Projected LL97 Fines From 2035-2050 Based on Projected Grid Scenario				
	LL97 of 2022 Emissions Limits				
	Total Fine From 2035-2039	Total Fine From 2040-2049	Total Fine From 2035-2049	Fine Avoidance From 2035-2049	Annual Fine From 2050 Onward
BAU (2019 Consumption)	$1,268,157	$2,838,931	$4,107,087	-	$484,059
Low	$0	$78,362	$78,362	$4,028,725	$204,931
Mid	$0	$0	$0	$4,107,087	$110,322
High	$0	$0	$0	$4,107,087	$109,362
Max	$0	$0	$0	$4,107,087	$92,055

1. 2022 emissions limits are calculated using the building emissions factors provided in the LL97 rules, which are based on Energy Star property types.
2. Fine calculations for 2024-2029 and 2030-2034 are based on GHG coefficients provided in LL97 of 2022.

Projected LL97 Fines From 2035-2050 Based on CLCPA Grid Scenario

Fines projected for baseline for 2035-2049
No fines projected from 2035-2049 for all packages

Packages	Projected LL97 Fines From 2035-2050 Based on CLCPA Grid Scenario				
	LL97 of 2022 Emissions Limits				
	Total Fine From 2035-2039	Total Fine From 2040-2049	Total Fine From 2035-2049	Fine Avoidance From 2035-2049	Annual Fine From 2050 Onward
BAU (2019 Consumption)	$970,033	$2,279,232	$3,249,264	-	$433,138
Low	$0	$0	$0	$3,249,264	$147,774
Mid	$0	$0	$0	$3,249,264	$48,905
High	$0	$0	$0	$3,249,264	$47,511
Max	$0	$0	$0	$3,249,264	$34,978

1. 2022 emissions limits are calculated using the building emissions factors provided in the LL97 rules, which are based on Energy Star property types.
2. Fine calculations for 2024-2029 and 2030-2034 are based on GHG coefficients provided in LL97 of 2022.

Financial & Carbon Summary - Recommended Package is CO_2 Mid

Meets 80x35 Target (CLCPA Grid, Y/N)	CO_2 Light (N)	CO_2 Mid (N)	CO_2 High (Y)	CO_2 Max (Y)
Carbon Emissions in 2035 [tCO2e] (CLCPA Grid)[3]	806	43% Decrease → 456	453	**385**
NPV (2023-2035)[1]	$1,162,015	$871,356	$542,241	($18,995,115)
NPV (Asset Life)[1]	$3,089,903	$2,808,902	$2,383,963	($19,860,357)
Base Capital Cost[2]	($3,488,371)	($4,465,861)	($4,465,861)	($5,859,984)
Incremental Capital Cost[2]	($4,186,130)	($5,316,271)	($5,852,787)	($38,048,862)
Total Capital Cost[2]	($7,674,501)	($9,782,132)	($10,318,648)	($43,908,846)
Landlord Annual Energy Cost Savings[2]	$231,617	8% Increase → $250,325	$250,751	$312,414
Tenant Annual Energy Cost Savings[2]	($144,455)	($147,242)	($147,998)	($135,727)
Annual Repairs & Maintenance Savings	$3,000	$3,000	$3,000	$3,000
Incentives	$2,688,848	$3,425,212	$3,450,201	$4,350,888
Landlord Payback [yrs]	**6.4**	**7.5**	**9.5**	**106.8**

CO2 Light: Replace fans not connected to ERV, replace PTAC with PTHP in apartments, change all AC to HP in amenity spaces, demand-controlled ventilation in fitness room, reduce laundry hot water temperature, install parking garage ventilation CO/NO2 control, optimize steam heating for peak demand, install flue gas economizer, replace condensing clothes dryers with high efficiency condensing dryers, install low flow shower heads, install high energy efficient appliances

CO2 Mid: CO2 Light + install Energy Recovery (ERV) for corridor ventilation, install partial domestic hot water electrification (80%), replace the EMR AC unit needing replacement, domestic cold water pumping optimization, install garage roll-up door, continue to offer building wifi

CO2 High: CO2 Mid + increase domestic hot water electrification to 95%, replace condensing clothes dryers with high efficiency heat pump type

Notes:

1. NPV calculated with 6% real discount rate
2. Base and incremental capital costs listed are based on current cost estimates and excludes future construction escalation costs. Annual energy cost savings listed are based on current 2023 estimates and exclude benefit from future utility cost escalations.
3. Carbon emissions in 2035 (annual, not cumulative) based on CLCPA grid.

Landlord and Tenant energy savings – Recommended Package CO2 Mid

	Tenant	Landlord
	Electricity Annual Savings	Natural Gas Annual Savings
AS005 - Replace PTAC with PTHP	($204,187)	$113,451
TL002 - Energy Efficient Appliances	$32,005	-
TL005 - Replace Condensing Dryers with Heat Pump Dryer	$24,939	$0
Total Annual Savings	($147,242)	$113,451
Total Annual Savings per Apartment (417 apts)	($353)	$272

Recommended Package – CO_2 Mid

- Meets ESRT 80% reduction with CLCPA grid
- Meets LL 97 2040 targets based on Projected Grid
- Replaces and upgrades failing corridor ventilation and elevator machine room space cooling
- ECMs that contributed to large CO2 emission reductions are related to electrification for space heating/cooling and domestic hot water:
  - AS05 Replace apartment PTAC units with PTHP
  - EL01 Change all AC to heat pumps in amenity spaces
  - EL06 Domestic water heat pump partial electrification – 80%

The Victory Case Study

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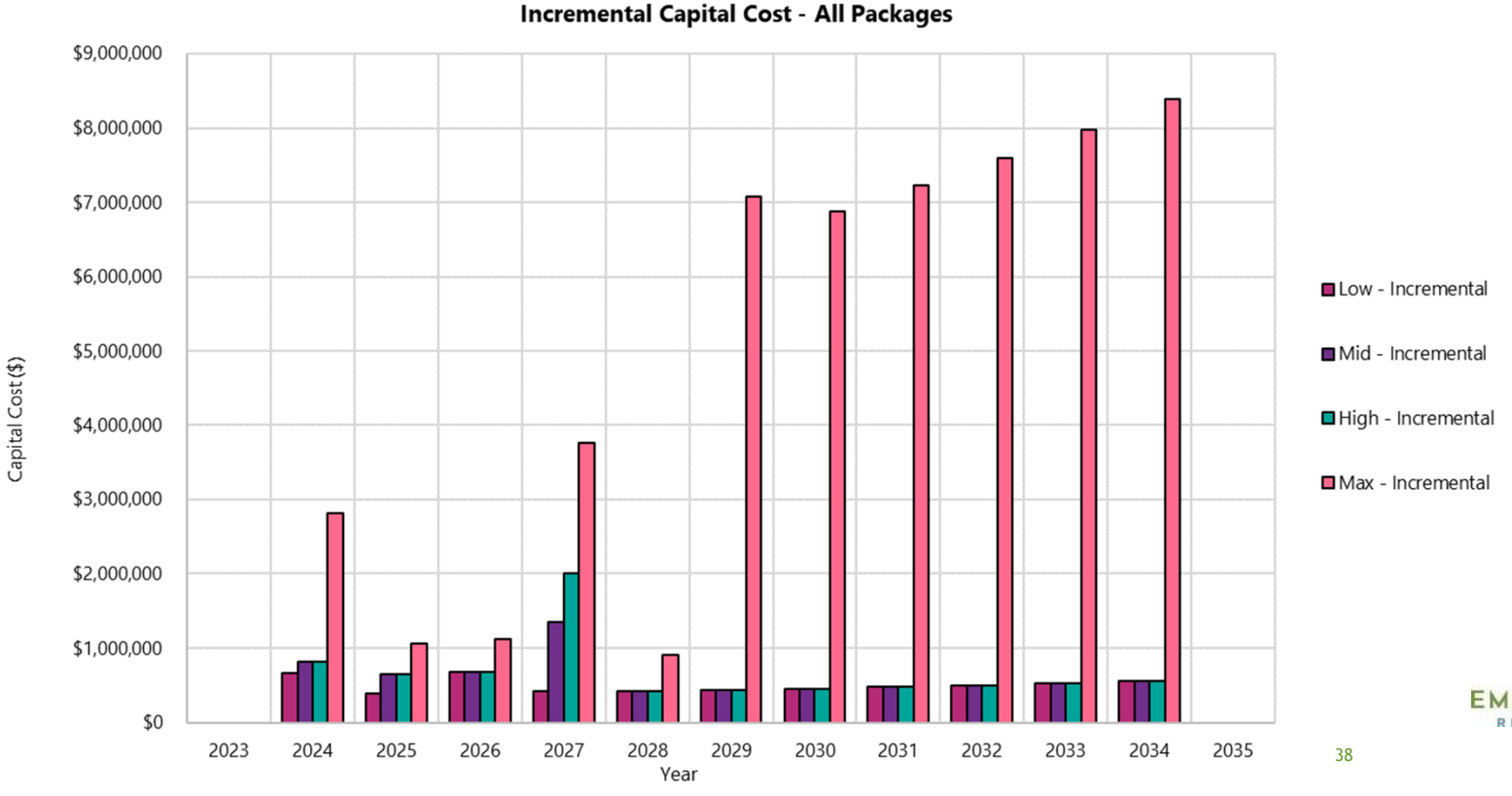
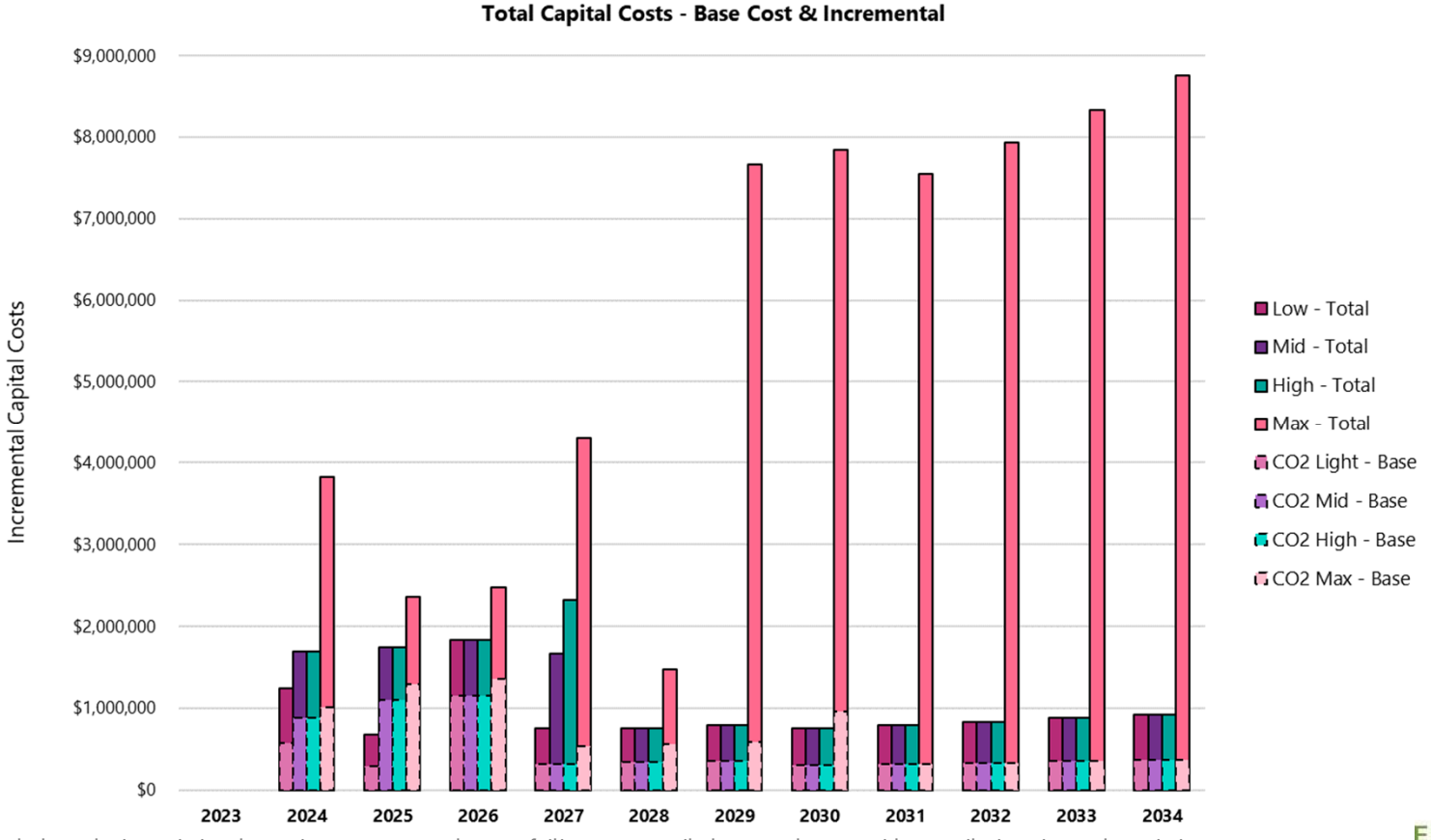
Annual Incremental Capital Cost per Package

Capital investments and improvements are planned in the first 5 years to meet LL97 limits by 2030
Partial Domestic Hot Water electrification is planned for 2027 after hot water efficiency measures are in place or more than half-way through completion, on-going apartment appliance and PTHP replacements into 2035



Annual Incremental Capital Cost vs. Base Cost per Package



Notes:
Base costs include replacing existing domestic water pumps that are failing, new vestibule entry door, corridor ventilation air supply, existing amenity space heating/cooling unit replacement, EMR AC unit replacement, elevator modernization, PTAC unit replacements and repair, aging fan replacements, planned steam system repairs for optimization, planned apartment appliance upgrades

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The Victory Next Steps – 2024 Projects

The recommended 2024 measures are focused on improving ventilation efficiencies in general areas and electrifying apartment heating and appliance upgrades, along with base building efficiencies, ~2.3 year payback

Project	Base Cost ($)	2024 Total Incremental Cost ($)	Total Cost ($)	Anticipated Incentives ($)	Total 2024 Cost w/ Incentives ($)	Annual Landlord Energy Cost Savings ($)
Reduce Laundry Hot Water Temperature	$0	($24,382)	($24,382)	$8,247	($16,135)	$3,950
Domestic Cold Water Pumping Optimization	($167,416)	($36,194)	($203,610)	$11,826	($191,784)	$5,829
Demand Controlled Ventilation	$0	($30,134)	($30,134)	$49	($30,085)	$3,142
VFD CO/NO2 Control for Garage Exhaust	$0	($68,873)	($68,873)	$41,749	($27,124)	$18,738
Replace Rooftop Fans Not Connected to ERV	($229,821)	($76,894)	($306,715)	$179,077	($127,638)	$36,281
Garage Entrance Roll-up door	$0	($105,605)	($105,605)	$49,596	($56,009)	$3,259
EMR Conditioning	($141,689)	($4,051)	($145,740)	$9,048	($136,692)	$3,819
Optimization for Peak Heating Demand	($63,448)	$0	($63,448)	$30,888	($32,560)	$13,176
Replace Showerheads with Low GPM Fixture[1]	$0	($24,096)	($24,096)	$8,948	($15,148)	$4,236
Energy Efficient Appliances[1]	($139,208)	$0	($139,208)	$6,648	($132,560)	$0
Flue Gas Economizer	$0	($99,845)	($99,845)	$25,974	($73,871)	$16,710
Replace PTAC with PTHP[1]	($85,877)	($338,222)	($424,099)	$150,492	($273,607)	$13,329
Replace Condensing Dryers with heat pump dryers[1]	($51,886)	($5,986)	($57,872)	$8,815	($49,058)	$0
Total LL97 Budget	($879,345)	($814,282)	($1,693,627)	$531,357	($1,162,271)	$122,469

Notes:

1. Includes implementation costs, incentives and savings in 2024. Refer to Appendix for ECM implementation 2024-2034.

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The Chesapeake Case Study

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The Chesapeake - Current Building Systems

- Built in 2000, 30 stories, 208 units,
- 167,941 SF: 163,685 SF Residential 4,256 SF retail
- Boilers
  - 5,833 MBH dual fuel fire-tube low pressure steam boilers
  - Original to the building
  - Vacuum return
  - Building steam and domestic hot water
- Apartment heating/cooling
  - Air-cooled PTAC units with steam coil
- Common building spaces and retail served by DX unit with steam heating coils and AHU's

2019 Energy Breakdown by Utility

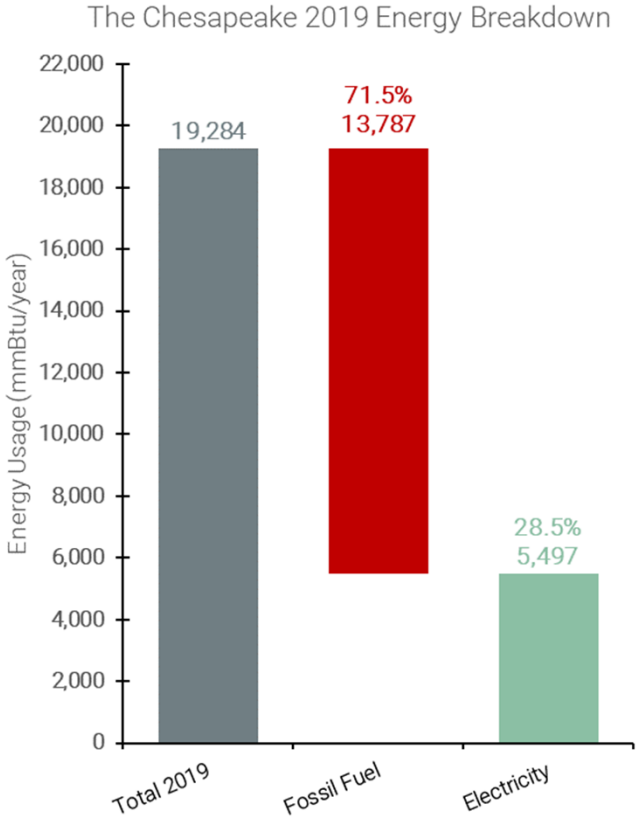
Building Energy Utilization Index = 93.5 kBtu/SF/year

Electricity

- 28.5% of energy usage
- 29.0% of CO_2e emissions

Fossil Fuel

- 71.5% of energy usage
- 71.0% of CO_2e emissions



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2019 Operational Cost Breakdown by Utility

Estimated Fuel Oil #2/Natural Gas vs Electricity Operational Costs

2019 utility operational cost = $602,570

Electricity

- 53.3% of operational costs
- 28.5% of energy usage

Fossil Fuel

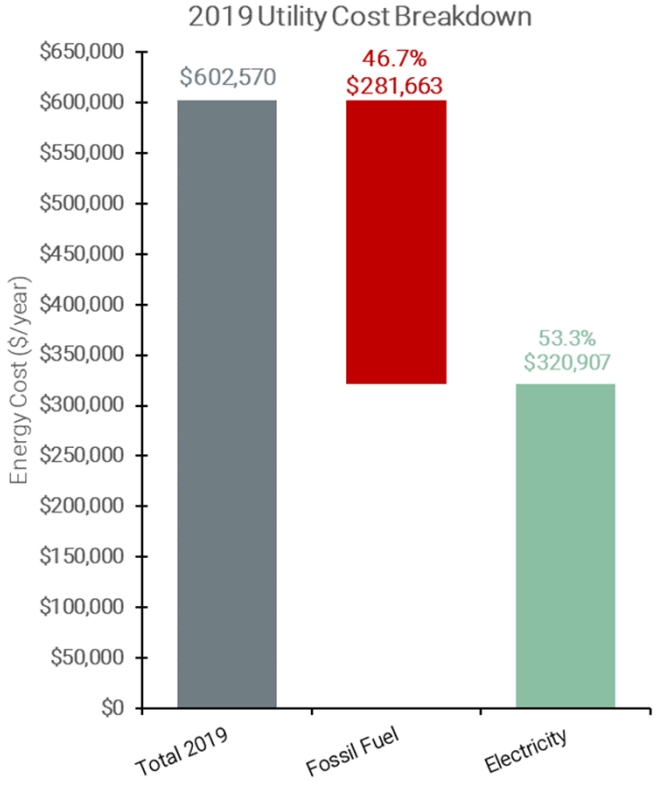
- 46.7% of operational costs
- 71.5% of energy usage

Blended Utility Rates (estimated)

Natural Gas = $2.00/therm = **$0.020/kBtu**

BB Electricity = $0.16/kWh = **$0.049/kBtu**

Res Electricity = $0.23/kWh = **$0.067/kBtu**



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2019 CO_2e Emissions Breakdown by Utility

Electricity

- 29.0% of CO_2e emissions
- 28.5% of energy usage

Natural Gas

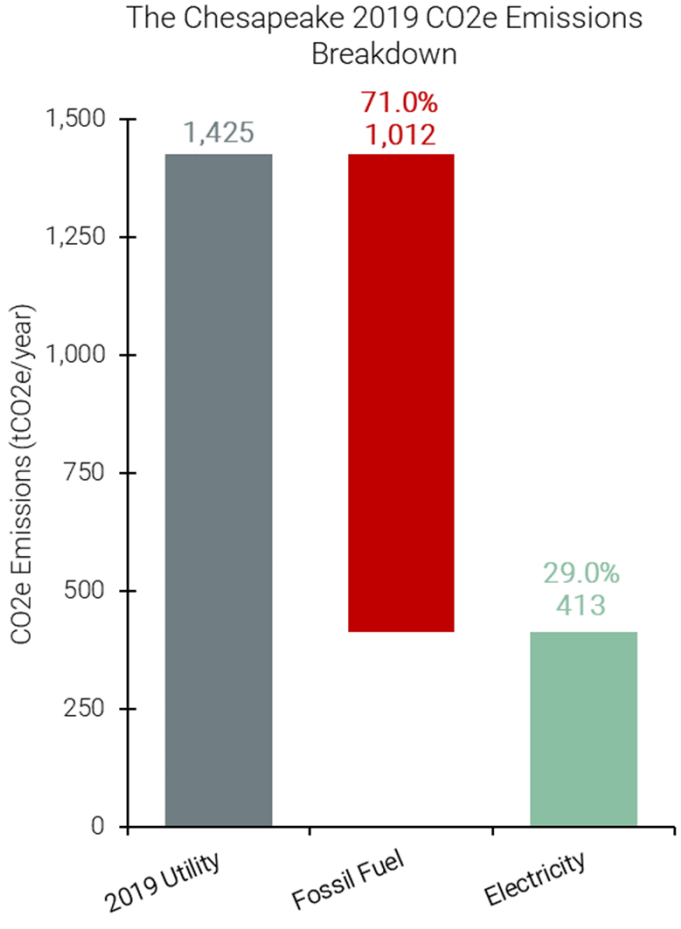
- 71.0% of CO_2e emissions
- 71.5% of energy usage

2019 Electricity – 256.0 tCO_2e/GWh (Luthin)

2022 Electricity – 286.0 tCO_2e/GWh (Luthin)

Fuel Oil #2 – 253.21 tCO_2e/GWh (LL97)

Natural Gas – 181.22 tCO_2e/GWh (LL97)



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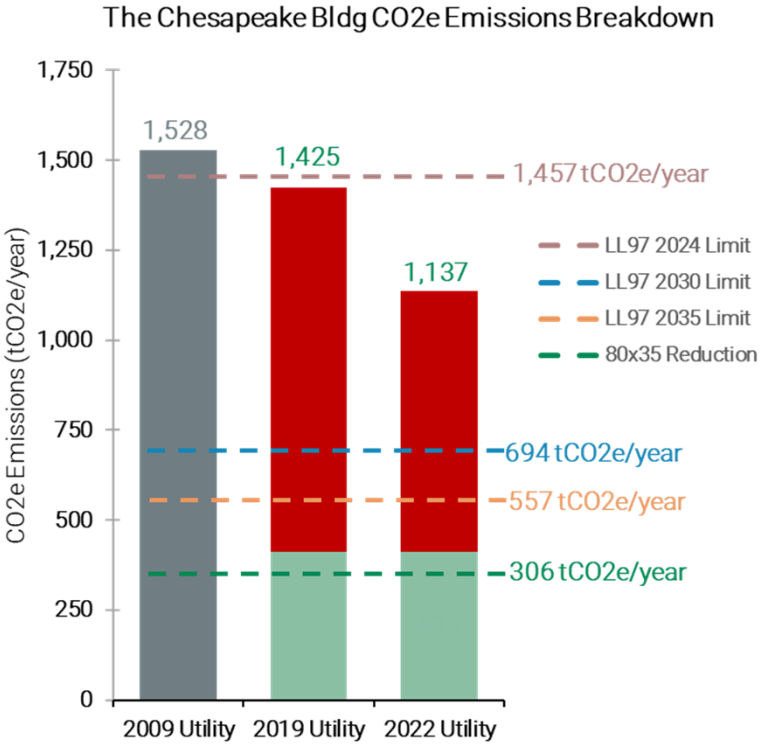
The Chesapeake Current Status for LL97 and 80x35 Challenge



Key Takeaways:

- The building switched from Fuel Oil to Natural Gas by 2022.
- Building meets 2024 Limit of 1,457 tCO_2e/year
- 39.0% reduction is required to meet LL97 2030 target of 694 tCO_2e/year
- 51.0% reduction is required to meet LL97 2035 target of 557 tCO_2e/year
- 73.1% reduction is required to meet ESRT 80x35 goal

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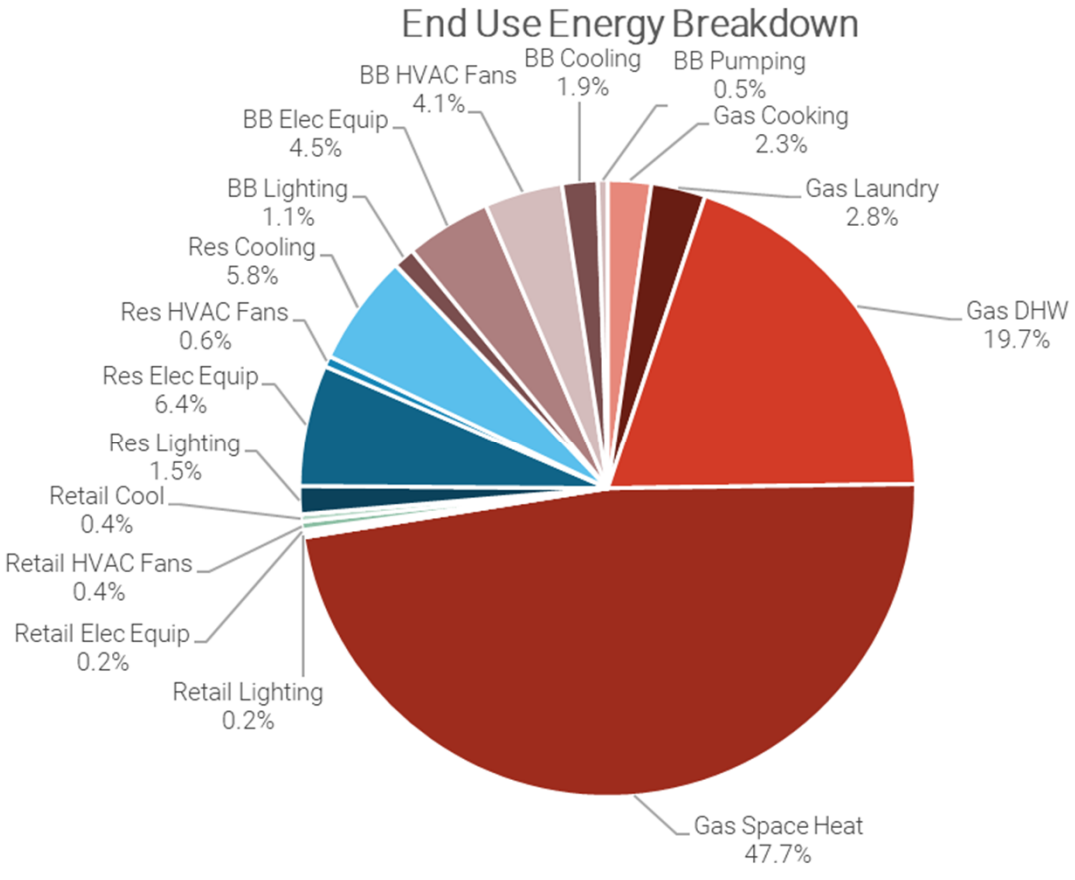
The Chesapeake Energy Model: 2019 Energy Breakdown

Analyzes major end-uses and highlight opportunities for improvement

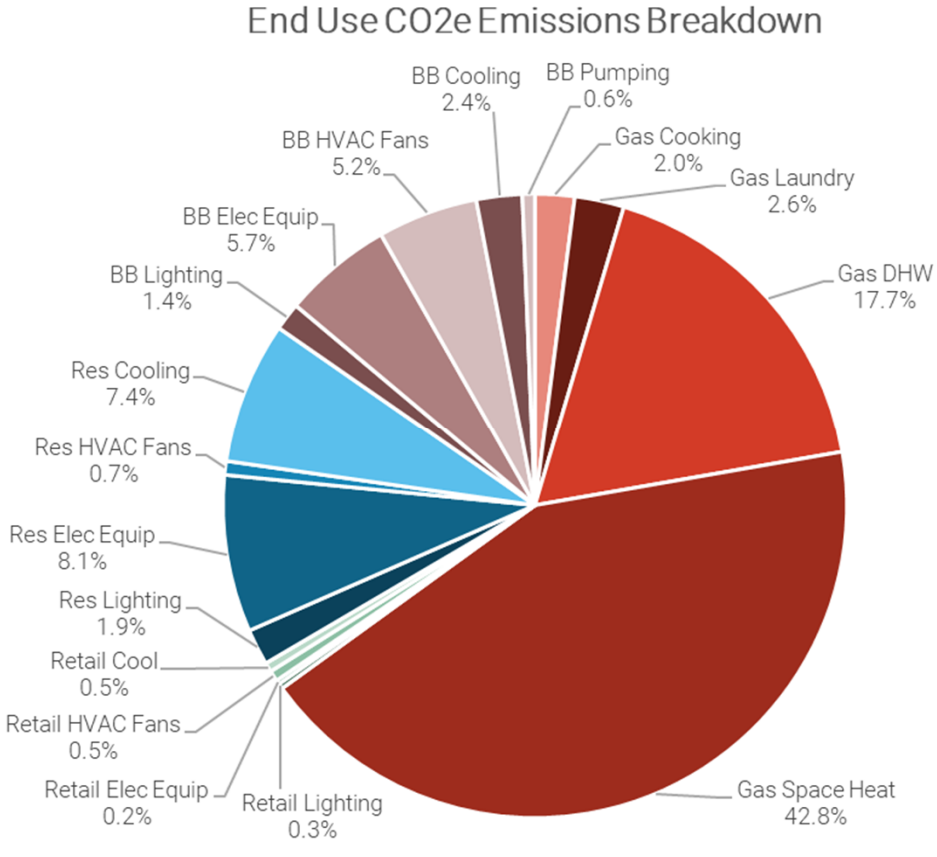
- Residential Tenants ~19.4%
- Base Building Electricity 12.1%
- Space Heating 47.7%
- DHW 19.7%
- Retail Tenants ~1.2%



The Chesapeake Energy Model: 2019 CO_2e Emissions Breakdown

Analyzes major end-uses and highlight opportunities for improvement

- Residential Tenants ~22.7%
- Base Building Electricity 15.3%
- Space Heating 42.8%
- DHW 17.7%
- Retail Tenants ~1.5%



The Chesapeake Case Study

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ECM Packages - Recommended Package is CO_2 Mid

Four packages of ECMs were developed to optimize NPV and CO_2 reductions

1

CO_2 Light

Space Heat Partial Electrification: PTHP for Apartment Heat

2

CO_2 Mid

Space Heat Partial Electrification: PTHP for Apartment Heat and ERV

Domestic Hot Water Heating Electrification - 67%

3

CO_2 High

Space Heat Full Electrification, VRF for Base Building, and ERV

Domestic Hot Water Heating Electrification - 95%

NYKC (Tenant) Electrification (VRF)

4

CO_2 Max:

Space Heat Full Electrification and ERV

Domestic Hot water Heating Electrification- 100%

NYKC (Tenant) Electrification

Carbon Reduction

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ECM Phases & Implementation Timeline: CO_2 Mid

ENERGY CONSERVATION MEASURES (ECMS)			IMPLEMENTATION TIMELINE											
Phase	**Tag**	**Short Name**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**
Phase 1	AS003	Replace rooftop exhaust fans not connected to ERV	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Phase 1	CO002	Demand controlled ventilation	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Phase 1	CO003	VFD CO/NO2 Control for Garage Exhaust	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Phase 1	DW002	Reduce laundry hot water temperatures	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Phase 1	DW003	Domestic cold water pumping optimization	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Phase 1	EN004	Lobby entrance seal	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Phase 1	VT001	EMR conditioning	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Phase 2	AS001	Energy Recovery Replacement	0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Phase 2	SS001	Optimization of steam heating system for peak heating demand periods.	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Phase 2	EL006	Domestic Hot Water Heat Pump Semi-Partial Electrification	0%	0%	0%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Phase 3	AS004	Replace apartment PTAC with PTHP	9%	18%	27%	36%	45%	55%	64%	73%	82%	91%	100%	100%
Phase 3	DW001	Replace Showerheads With Low Flow GPM & Provide Aerators to Faucets.	25%	50%	75%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Phase 3	SS002	Flue gas economizer	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Phase 3	TL005	Replace Condensing Dryers With Heat Pump Washer/Dryer	17%	33%	50%	67%	83%	100%	100%	100%	100%	100%	100%	100%
Phase 4	TL004	Consolidate Wifi to Building provided wifi	20%	40%	60%	80%	100%	100%	100%	100%	100%	100%	100%	100%

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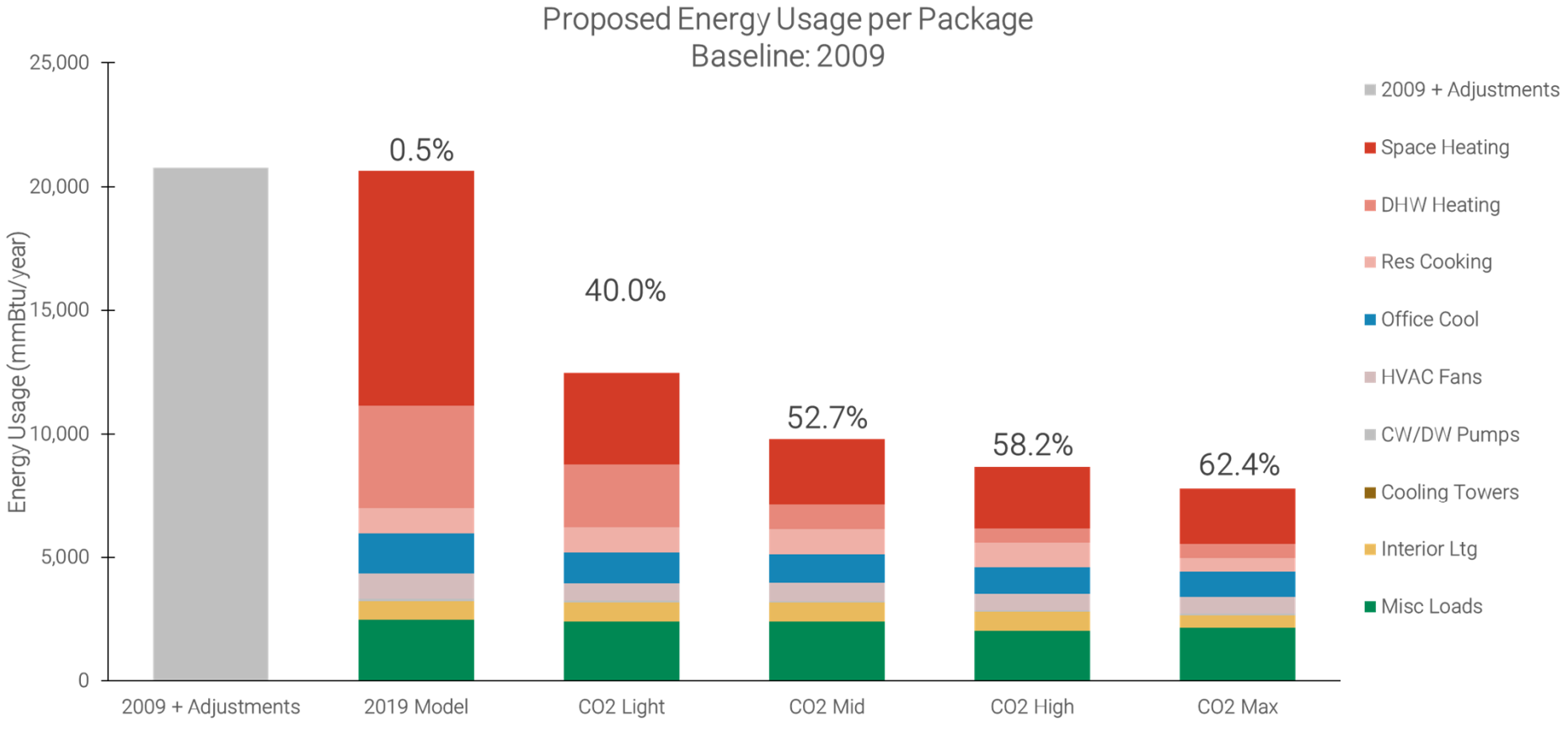
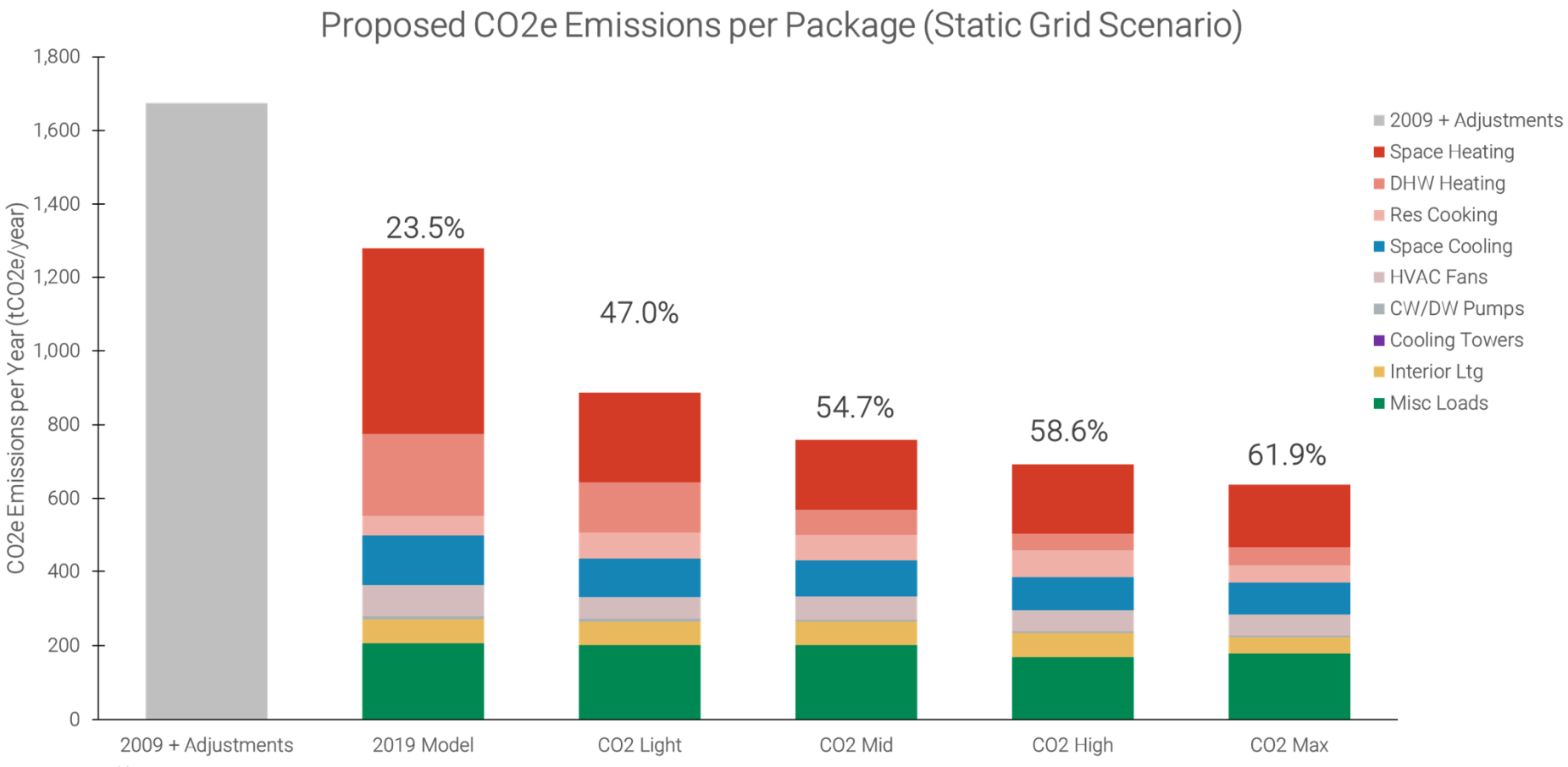
The Chesapeake ECM Package Comparison: Energy

Baseline: 2019



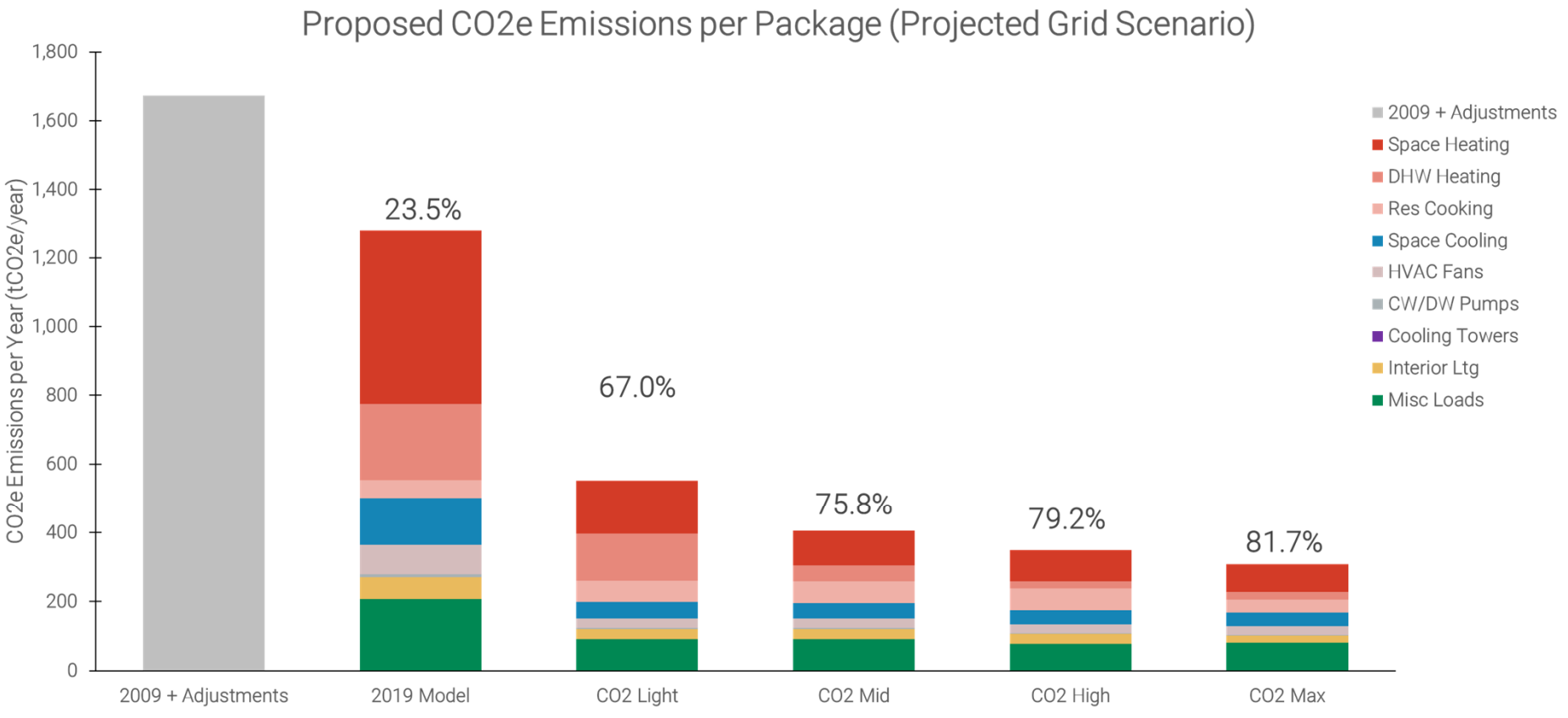
Notes:
2009 + Adjustments are estimated from 2022 energy use with adjustments from building improvements (lighting and fuel switch from fuel oil to natural gas in 2021)

Projected CO2 Emissions: Static 2019 Grid Scenario



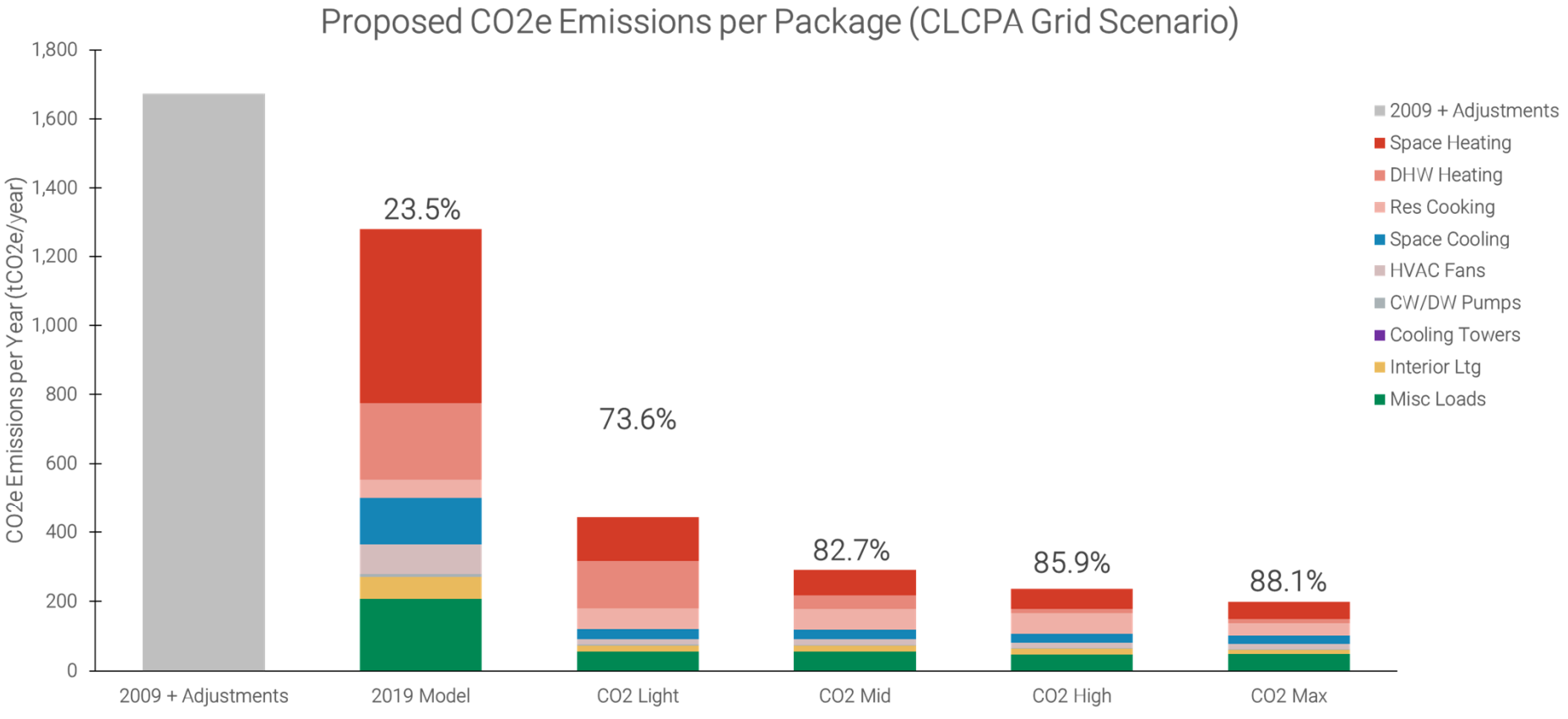
Notes:
2009 + Adjustments are estimated from 2022 energy use with adjustments from building improvements (lighting and fuel switch from fuel oil to natural gas in 2021) and with 2009 electricity grid factors

Projected CO2 Emissions: Projected Grid Scenario



Notes:
2009 + Adjustments are estimated from 2022 energy use with adjustments from building improvements (lighting and fuel switch from fuel oil to natural gas in 2021) and with 2009 electricity grid factors

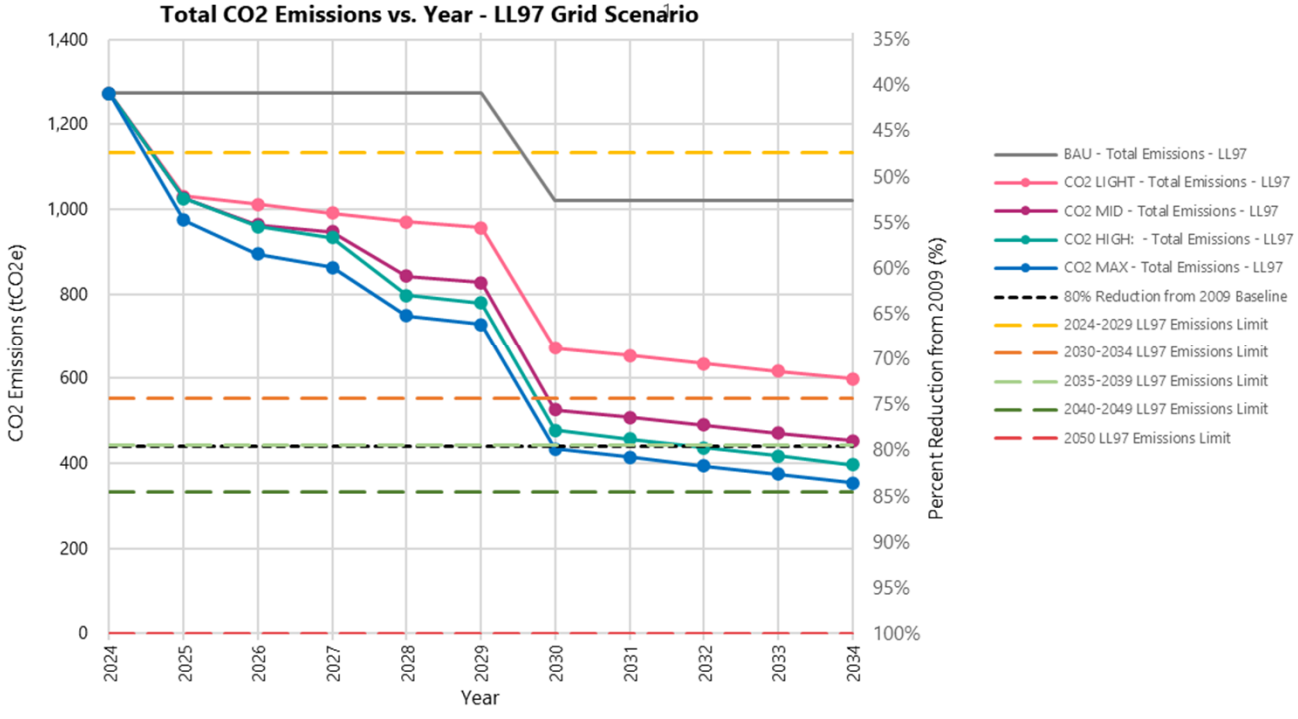
Projected CO2 Emissions: CLCPA Grid Scenario



Notes:
2009 + Adjustments are estimated from 2022 energy use with adjustments from building improvements (lighting and fuel switch from fuel oil to natural gas in 2021) and with 2009 electricity grid factors

Projected Annual Carbon Emissions – LL97 Compliance

Current baseline incurs fines in 2024, all packages are below 2024 LL97 emissions limits, CO2 High & Max are below 2035 limits



1. 2035-2039 and 2040-2049 limits are shown for reference only. Compliance cannot be confirmed until GHG emissions coefficients for those periods are released.
2. 80% Reduction from 2009 Baseline are estimated from 2022 energy use to 2009 emission coefficients

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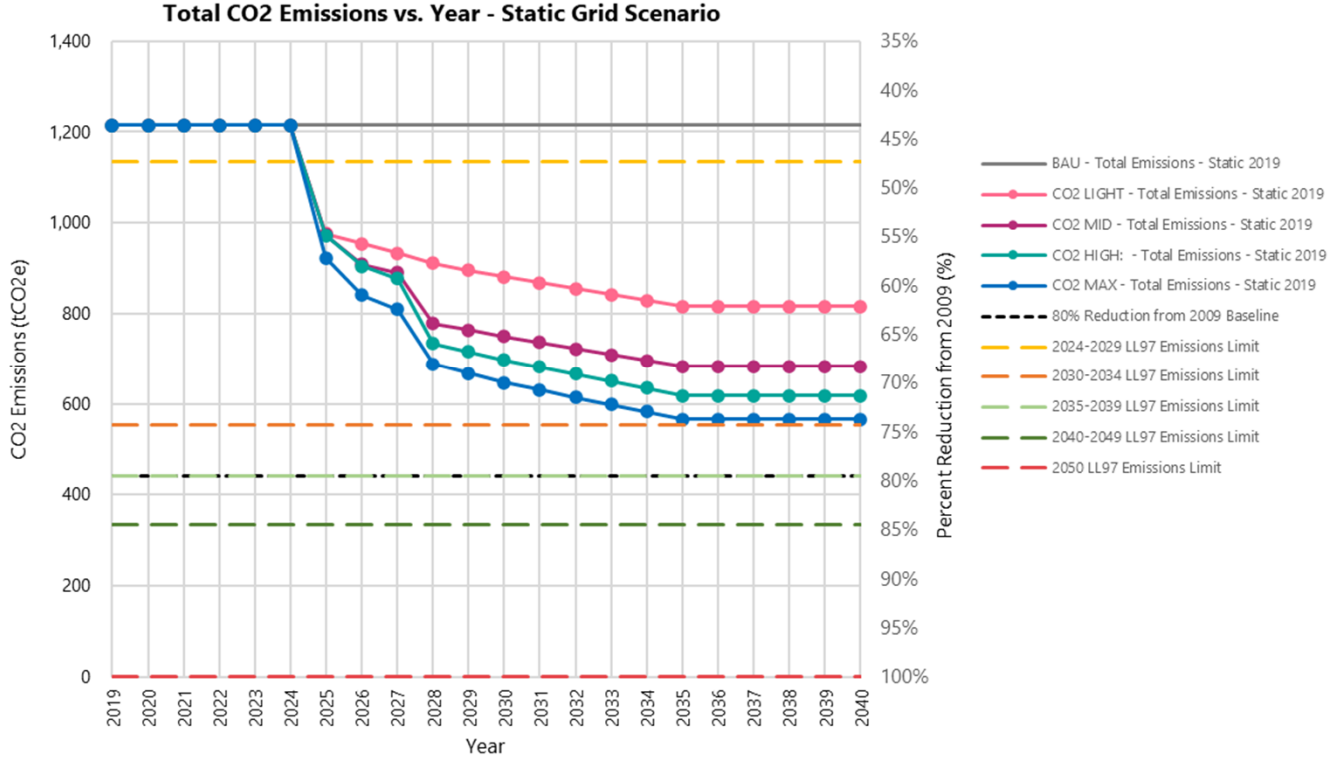
Projected Annual Carbon Emissions – Static 2019 Grid Scenario

No packages would meet **80% reduction** from 2009 baseline by **2035** without grid decarbonization;
No packages would meet **average long-term LL97** limits without grid decarbonization



1. 2035-2039 and 2040-2049 limits are shown for reference only. Compliance cannot be confirmed until GHG emissions coefficients for those periods are released.
2. 80% Reduction from 2009 Baseline are estimated from 2022 energy use to 2009 emission coefficients

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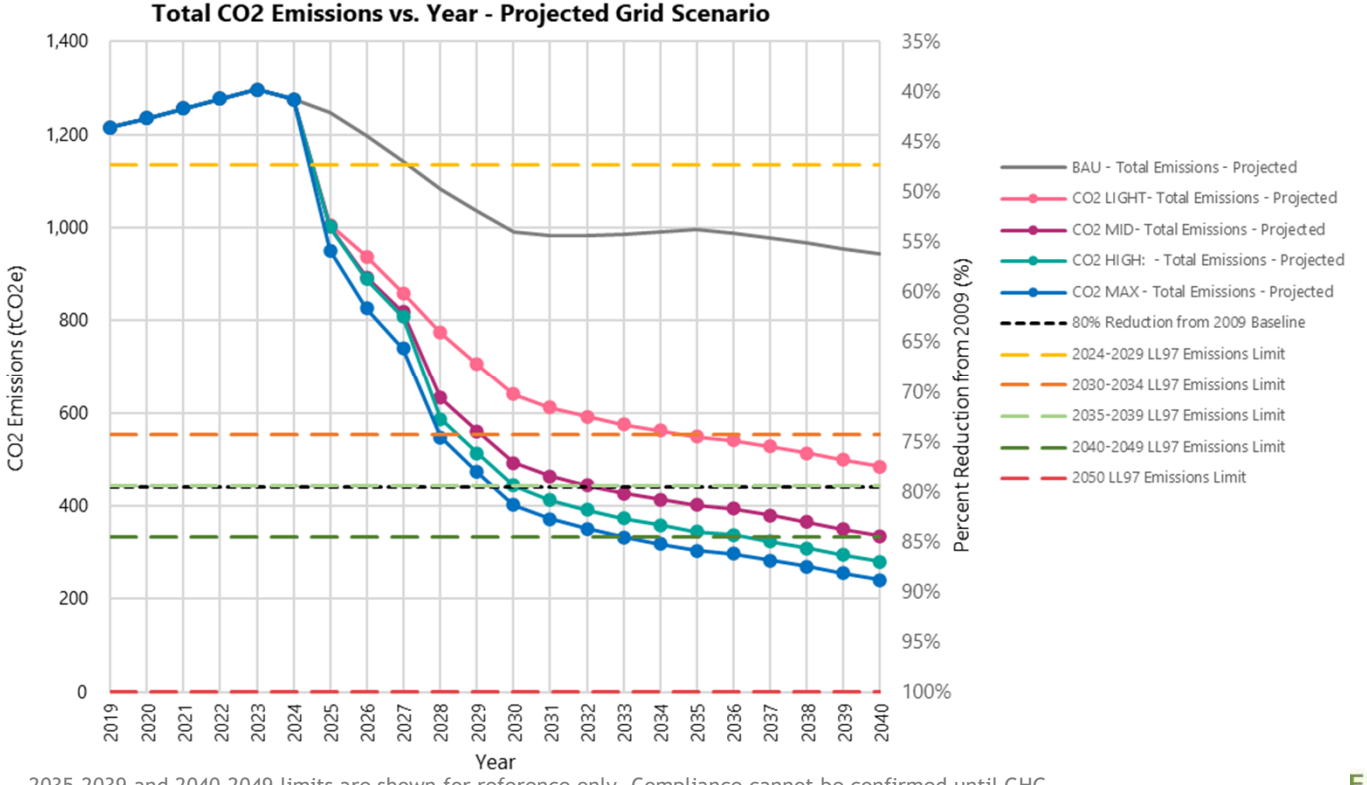
Projected Annual Carbon Emissions – Projected Grid Scenario

CO_2 Max, High, and Mid packages meet **80% reduction** from 2009 baseline by **2035**;
CO_2 Mid, Max & High packages would meet **the 2040-2049 Limit**



1. 2035-2039 and 2040-2049 limits are shown for reference only. Compliance cannot be confirmed until GHG emissions coefficients for those periods are released.
2. 80% Reduction from 2009 Baseline are estimated from 2022 energy use to 2009 emission coefficients

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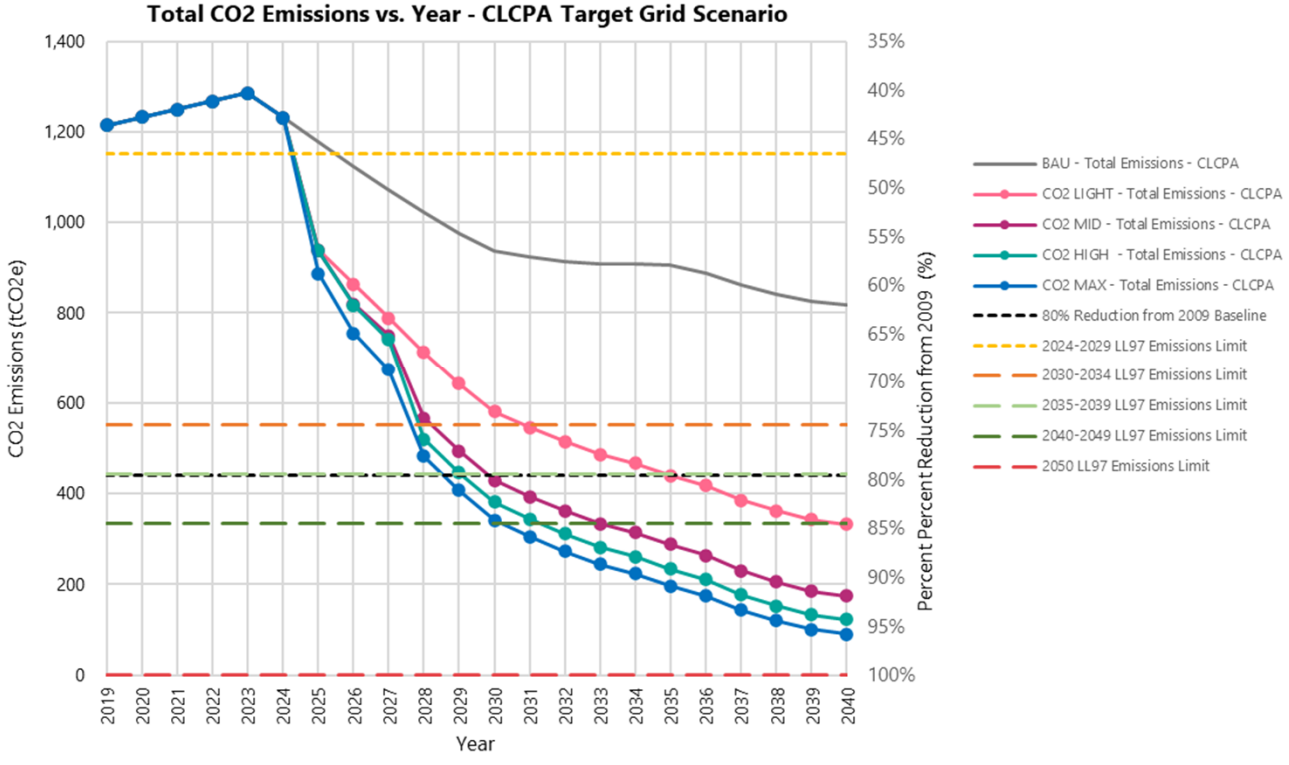
Projected Annual Carbon Emissions – CLCPA Grid Scenario

All packages meet **80% reduction** from 2009 baseline by **2035;**
All packages meet **the 2040-2049 LL97 Emissions Limit**



1. 2035-2039 and 2040-2049 limits are shown for reference only. Compliance cannot be confirmed until GHG emissions coefficients for those periods are released.
2. 80% Reduction from 2009 Baseline are estimated from 2022 energy use to 2009 emission coefficients

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Percent Carbon Emissions Reductions – All Grid Scenarios

80x35 target based on reductions from 2009 baseline

Reductions from 2019 baseline show impact of packages compared to current usage

STATIC GRID SCENARIO

	2019 - 2030	2019 - 2035	**2009 - 2030**	**2009 - 2035**
CO2 MAX	-46.8%	-53.4%	**-70.6%**	**-74.3%**
CO2 HIGH	-42.6%	-49.1%	**-68.3%**	**-71.9%**
CO2 MID	-38.4%	-43.8%	**-66.0%**	**-68.9%**
CO2 LIGHT	-27.5%	-32.9%	**-59.9%**	**-62.9%**

No packages would meet **80% reduction** from 2009 baseline by **2035** or the **average long-term LL97 limit**

PROJECTED GRID SCENARIO

	2019 - 2030	2019 - 2035	**2009 - 2030**	**2009 - 2035**
CO2 MAX	-67.0%	-75.0%	**-81.7%**	**-86.2%**
CO2 HIGH	-63.5%	-71.7%	**-79.8%**	**-84.3%**
CO2 MID	-59.5%	-66.9%	**-77.6%**	**-81.7%**
CO2 LIGHT	-47.3%	-54.9%	**-70.9%**	**-75.1%**

All packages except CO_2 Light would meet **80% reduction** from 2009 baseline by **2035** and the **2035 LL97 emission limit**

CLCPA TARGET GRID SCENARIO

	2019 - 2030	2019 - 2035	**2009 - 2030**	**2009 - 2035**
CO2 MAX	-71.9%	-83.8%	**-84.5%**	**-91.1%**
CO2 HIGH	-68.6%	-80.8%	**-82.7%**	**-89.4%**
CO2 MID	-64.7%	-76.3%	**-80.5%**	**-86.9%**
CO2 LIGHT	-52.2%	-63.8%	**-73.6%**	**-80.0%**

All packages would meet **80% reduction** from 2009 baseline by **2035** and the **2035 LL97 emission limit**

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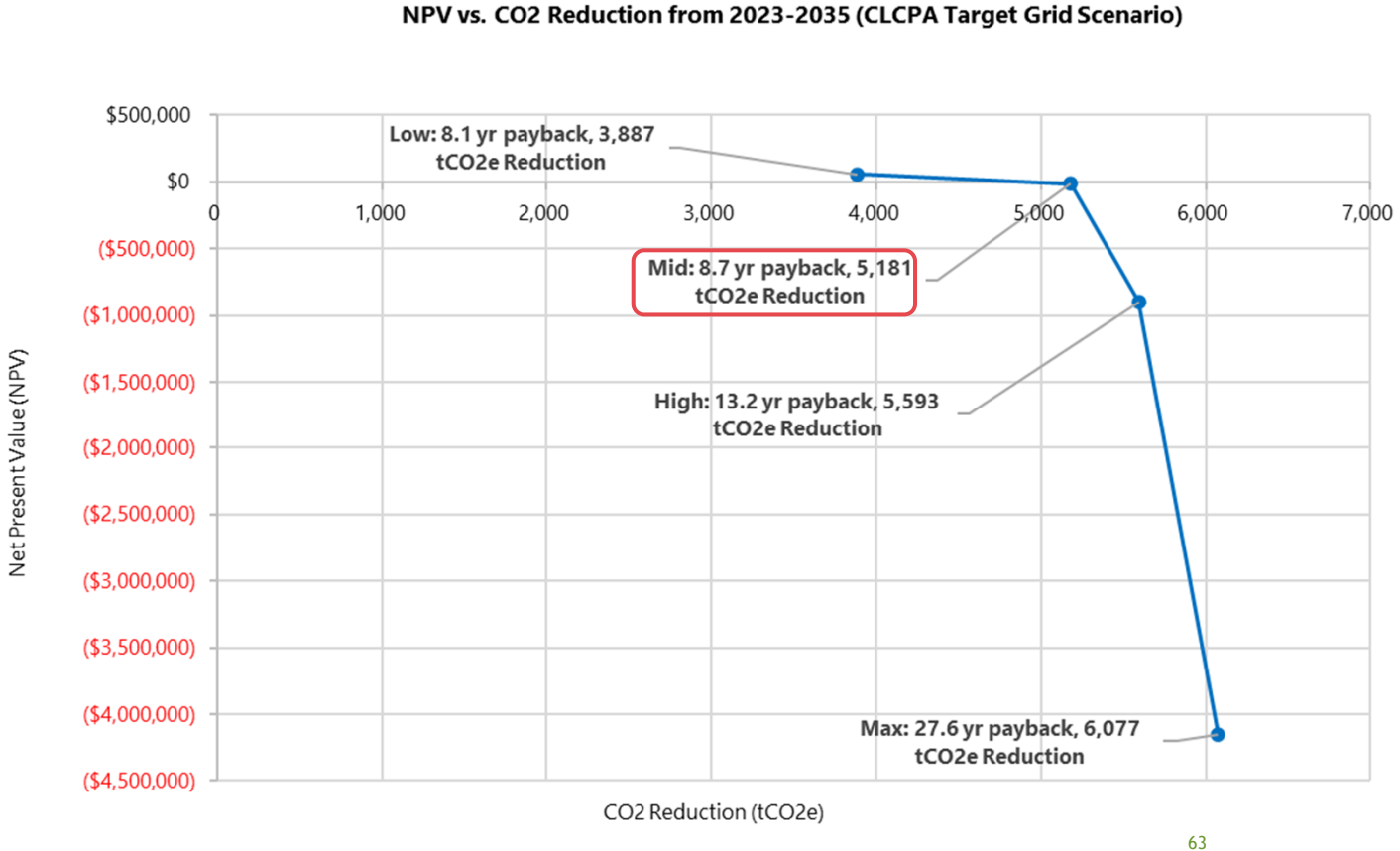
NPV, CO_2 Reductions and Simple Payback for all Packages

Net Present Value for 2023-2035; CO_2 reduction based on CLCPA scenario



NPV calculated with 6% real discount rate

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Projected LL97 Fines From 2024-2034

LL97 fines projected for 2024 but may be avoided with early implementation of ECM's;
Fines possible from 2030-2034 for Baseline and low package, though all packages offset the potential fines.

Packages	LL97 Fines From 2024-2034		
	2022 Proposed Emissions Limits		
	Total Fine From 2024-2029	Total Fine From 2030-2034	Fine Avoidance From 2024-2034
BAU (2019 Consumption)	$223,696	$628,361	-
Low	$37,283	$111,379	$703,395
Mid	$37,283	$0	$814,774
High	$37,283	$0	$814,774
Max	$37,283	$0	$814,774

1. 2022 emissions limits are calculated using the building emissions factors provided in the LL97 rules, which are based on Energy Star property types.
2. Fine calculations for 2024-2029 and 2030-2034 are based on GHG coefficients provided in LL97 of 2022.

Projected LL97 Fines From 2035-2050 Based on Projected Grid Scenario

Fines projected for the Baseline Low and Mid package, though all packages offset the fines

Packages	Projected LL97 Fines From 2035-2050 Based on Projected Grid Scenario				
	2022 Proposed Emissions Limits				
	Total Fine From 2035-2039	Total Fine From 2040-2049	Total Fine From 2035-2049	Fine Avoidance From 2035-2049	Annual Fine From 2050 Onward
BAU (2019 Consumption)	$716,301	$1,527,650	$2,243,951	-	$237,815
Low	$112,274	$277,899	$390,173	$1,853,778	$111,905
Mid	$0	$317	$317	$2,243,635	$70,760
High	$0	$0	$0	$2,243,951	$56,370
Max	$0	$0	$0	$2,243,951	$46,823

1. 2022 emissions limits are calculated using the building emissions factors provided in the LL97 rules, which are based on Energy Star property types.
2. Fine calculations for 2024-2029 and 2030-2034 are based on GHG coefficients provided in LL97 of 2022.

Projected LL97 Fines From 2035-2050 Based on CLCPA Grid Scenario

Fines projected for baseline and low package for 2035-2049, though all packages offset the fines

Packages	Projected LL97 Fines From 2035-2050 Based on CLCPA Grid Scenario				
	2022 Proposed Emissions Limits				
	Total Fine From 2035-2039	Total Fine From 2040-2049	Total Fine From 2035-2049	Fine Avoidance From 2035-2049	Annual Fine From 2050 Onward
BAU (2019 Consumption)	$565,739	$1,244,984	$1,810,724	-	$212,098
Low	$0	$0	$0	$1,810,724	$80,695
Mid	$0	$0	$0	$1,810,724	$37,856
High	$0	$0	$0	$1,810,724	$24,350
Max	$0	$0	$0	$1,810,724	$16,119

1. 2022 emissions limits are calculated using the building emissions factors provided in the LL97 rules, which are based on Energy Star property types.
2. Fine calculations for 2024-2029 and 2030-2034 are based on GHG coefficients provided in LL97 of 2022.

Financial & Carbon Summary - Recommended Package is CO_2 Mid

Meets 80x35 Target (CLCPA Grid, Y/N)	CO_2 Light (N)	CO_2 Mid (Y)	CO_2 High (Y)	CO_2 Max (Y)
Carbon Emissions in 2035 [tC02e] (CLCPA Grid)[3]	440	34% decrease → 288	233	197
NPV (2023-2035)[1]	$58,609	($11,643)	($894,108)	($4,154,179)
NPV (Asset Life)[1]	$408,178	$656,401	($48,216)	($3,505,276)
Base Capital Cost[2]	($685,096)	($1,075,376)	($1,837,986)	($2,421,572)
Incremental Capital Cost[2]	($2,625,786)	($3,489,283)	($5,121,341)	($9,929,906)
Total Cost	($3,310,882)	($4,564,660)	($6,959,327	($12,351,478)
Landlord Annual Energy Cost Savings[2]	$216,498	19% increase → $259,281	$278,432	$297,841
Tenant Annual Energy Cost Savings[2]	($116,105)	($113,438)	($95,965)	($89,250)
Annual Repairs & Maintenance Savings	$0	$840	$840	$840
Incentives	$877,037	$1,224,707	$1,439,912	$1,676,751
Landlord Payback [yrs]	**8.1**	**8.7**	**13.2**	**27.6**

CO2 Light: Replace fans not connected to ERV, replace PTAC with PTHP in apartments, demand-controlled ventilation in fitness room, reduce laundry hot water temperature, install parking garage ventilation CO/NO2 control, optimize steam heating for peak demand, install flue gas economizer, replace condensing clothes dryers with heat pump dryers, install low flow shower heads and faucet aerators, continue to offer building wifi

CO2 Mid: CO2 Light + install Energy Recovery (ERV) for corridor ventilation, install partial domestic hot water electrification (67%), replace the EMR AC unit, domestic cold water pumping optimization, repair lobby entrance seals

CO2 High: CO2 Mid + increase domestic hot water electrification to 95% of hot water load, change all AC to HP in amenity spaces, electrify heating system serving retail (day care), install high energy efficient appliances

Notes:

1. NPV calculated with 6% real discount rate
2. Base and incremental capital costs listed are based on current cost estimates and excludes future construction escalation costs. Annual energy cost savings listed are based on current 2023 estimates and exclude benefit from future utility cost escalations.
3. Carbon emissions in 2035 (annual, not cumulative) based on CLCPA grid.

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Landlord and Tenant energy savings – Recommended Package CO2 Mid

Energy Conservation Measure	Tenant	Landlord
	Electricity Annual Savings	Gas Annual Savings
AS004 - Replace PTAC with PTHP	($120,717)	$108,011
TL005 - Replace Condensing Dryers with Heat Pump Dryer	$7,279	$0
Total Annual Savings	($113,438)	$108,011
Total Annual Savings per Apartment (208 apartments)	($545.37)	$519.28

Recommended Package – CO_2 Mid

- Meets LL97 2030-2034 targets, Meets ESRT 80% reduction with Projected grid (and CLCPA grid)
- Replace end of life fans and optimize base building systems
  - AS01 Energy recovery ventilation
  - AS03 Replace rooftop exhaust fans not connected to ERV
- ECMs that contributed to large CO2 emission reductions are related to electrification for space heating/cooling and domestic hot water:
  - AS04 Replace apartment PTAC units with PTHP
  - EL06 Domestic hot water partial electrification (67%)

The Chesapeake Case Study

Baseline Energy Modeling
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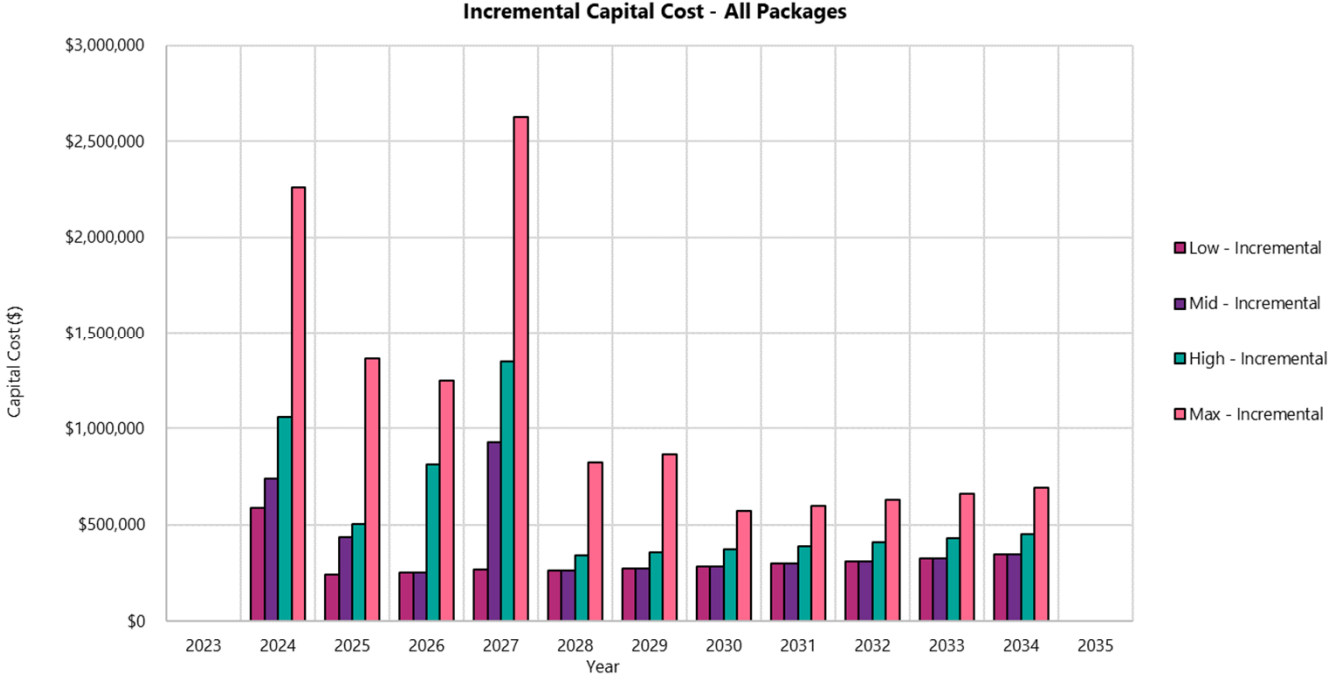
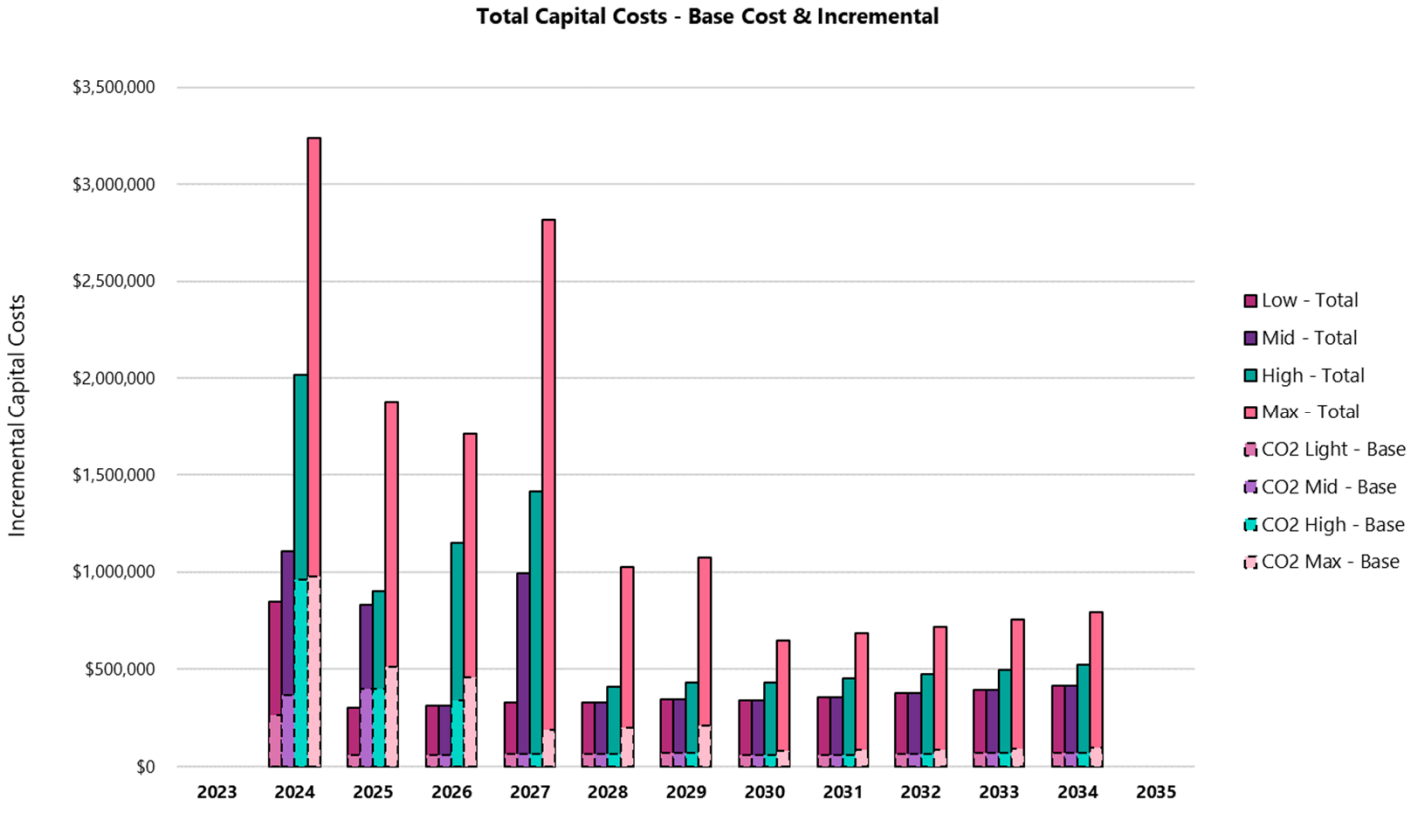
Annual Incremental Capital Cost per Package

Capital investments and improvements are planned in the first 5 years to meet LL97 limits by 2030
Partial Domestic Hot Water electrification is planned for 2027 after hot water efficiency measures are in place or more than half-way through completion, on-going apartment appliance and PTHP replacements into 2034



Annual Incremental Capital Cost vs. Base Cost per Package



Notes:
Base costs include replacing existing domestic water pumps at end of life, corridor ventilation unit replacement, EMR AC unit replacement, PTAC unit replacements and repair, retail space air handling unit replacement, lobby AC unit replacement, aging fan replacements, planned steam system repairs for optimization, window repairs

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The Chesapeake Next Steps – 2024 Projects

The recommended 2024 measures are focused on improving ventilation efficiencies in general areas and electrifying apartment heating and appliance upgrades, along with base building efficiencies, ~3.8 year payback

Project	Base Cost ($)	Incremental Cost ($)	Total Cost ($)	Anticipated Incentives ($)	Total Cost w/ Incentives ($)	Landlord Energy Cost Savings ($)
Replace Exhaust Systems	($206,549)	($65,720)	($272,269)	$90,902	($181,367)	$69,753
Demand controlled ventilation	$0	($30,134)	($30,134)	$2,181	($27,953)	$1,926
VFD CO/NO2 Control for Garage Exhaust	$0	($76,435)	($76,435)	$19,799	($56,636)	$13,472
Reduce laundry hot water temperatures	$0	($24,382)	($24,382)	$3,972	($20,410)	$3,567
Domestic cold water pumping optimization	($107,572)	($10,239)	($117,811)	$3,285	($114,526)	$1,344
Lobby entrance seal	$0	($37,137)	($37,137)	$11,619	($25,518)	$2,287
EMR conditioning	$0	($104,969)	($104,969)	$15,877	($89,092)	$7,772
Optimization of steam heating system for peak heating demand periods.	$0	($60,392)	($60,392)	$13,404	($46,988)	$12,039
Replace apartment PTAC with PTHP[1]	($43,540)	($210,436)	($253,976)	$62,459	($191,517)	$12,690
Replace Showerheads With Low Flow GPM & Provide Aerators to Faucets[1]	$0	($15,497)	($15,497)	$3,652	($11,845)	$2,431
Flue gas economizer	$0	($99,845)	($99,845)	$24,882	($74,963)	$19,671
Replace Condensing Dryers with Proposed Heat Pump Dryer[1]	($64,044)	($23,760)	($87,804)	$15,469	($72,335)	$0
Total	**($421,705)**	**($758,946)**	**($1,180,651)**	**$267,501**	**($913,150)**	**$130,336**

Notes:

1. Includes implementation costs, incentives and savings in 2024. Refer to Appendix for ECM implementation 2024-2034.

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298 Mulberry- Current Building Systems

- Built in 1986, 7 stories, 96 units,
- 65,241 SF: 53,316 SF Residential, 11,825 SF Retail
- Boiler
  - 6300MBH gas-fired, fire-tube steam boiler
  - Original to the building, 37 years
  - Building heat and domestic hot water
  - Supplemental 1200MBH gas-fired water heater
- Apartment heating/cooling
  - Ice Air air-cooled PTAC units with steam coil
  - 9 MBH to 13 MBH
- Common building spaces served by DX unit with steam heating coils and VRF system
- CVS
  - (1) 58 Tons Evapco low profile open cell forced draft cooling tower (CT) located on the roof, supplied and installed by landlord
  - (5) Trane GEHE series water to air heat pumps (WSHPs) in retail space ceiling, supplied and installed by tenant
  - 24/7 operation

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2022 Energy Breakdown by Utility

Energy Intensity vs. Carbon Intensity

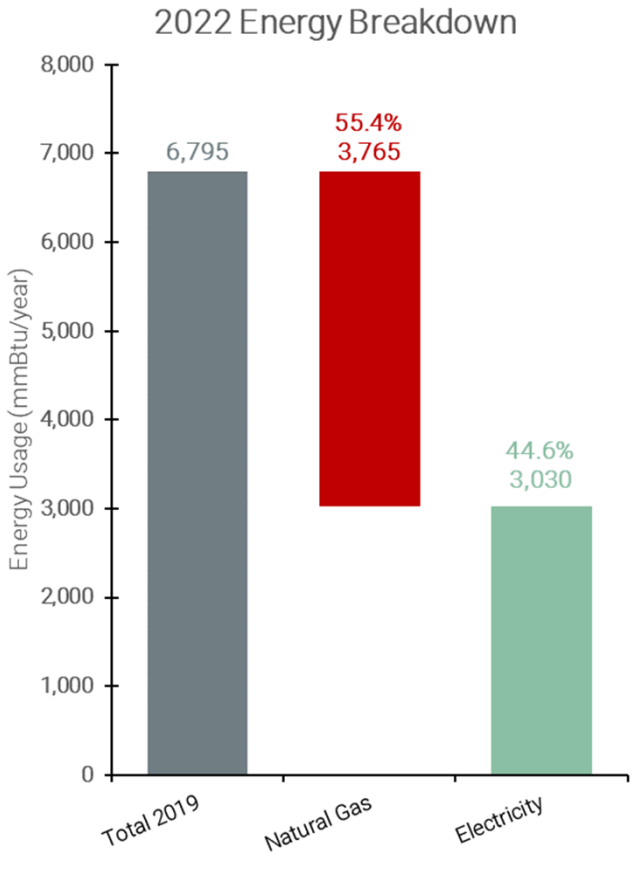
Natural Gas

- 55.4% of energy usage
- 44.0% of CO_2e emissions

Electricity

- 44.6% of energy usage
- 56.0% of CO_2e emissions

Year	Electricity (kWh/year)	Natural Gas (therms/year)	EUI (kBtu/SF/year)
2018	972,323	39,817	82.6
2019	1,187,600	41,978	93.4
2020	847,456	34,131	71.3
2021	871,465	36,773	75.3
2022	888,021	37,663	76.9



* 2019 data is 18-28% higher due to neighboring parcel sharing power from 298 Mulberry for construction

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2022 CO_2e Emissions Breakdown by Utility

Carbon Intensity vs. Energy Intensity

Natural Gas

- 44.0% of CO_2e emissions
- 55.4% of energy usage

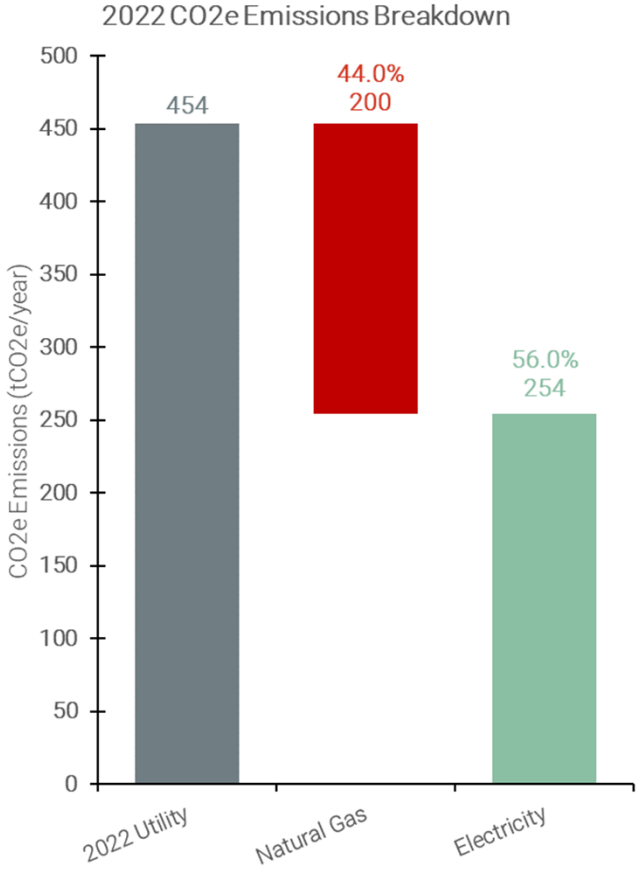
Electricity

- 56.0% of CO_2e emissions
- 44.6% of energy usage

2019 Electricity – 256.0 tCO_2e/GWh (Luthin)

2022 Electricity – 286.0 tCO_2e/GWh (Luthin)

Natural Gas - 181.21 tCO_2e/GWh (LL97)



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2022 Operational Cost Breakdown by Utility

Estimated Natural Gas vs Electricity Operational Costs

Natural Gas

- 33.2% of operational costs
- 55.4% of energy usage

Electricity

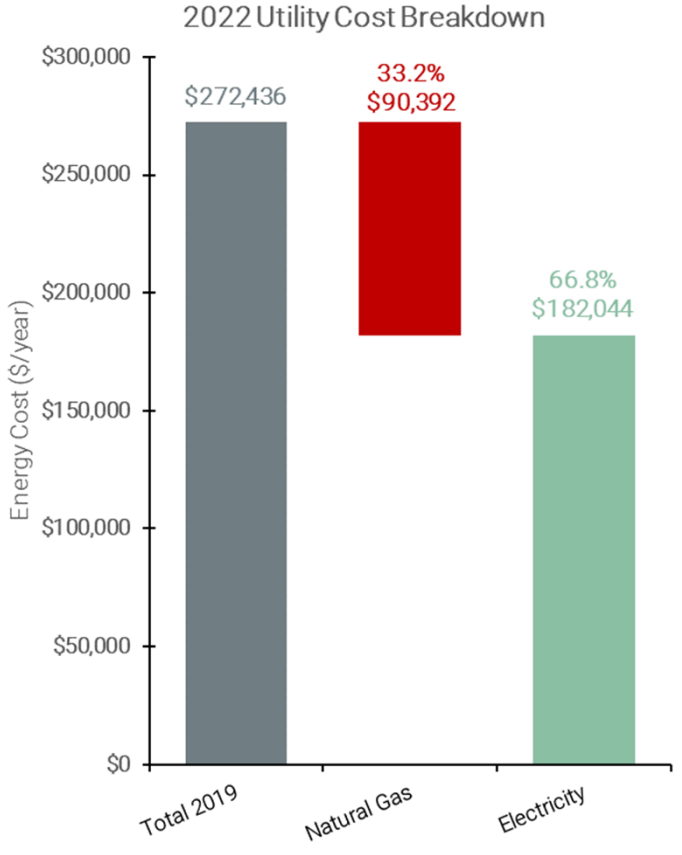
- 66.8% of operational costs
- 44.6% of energy usage

Blended Utility Rates (estimated)

Natural Gas = $2.40/therm = **$0.024/kBtu**

BB Electricity = $0.18/kWh = **$0.053/kBtu**

Res Electricity = $0.23/kWh = **$0.067/kBtu**



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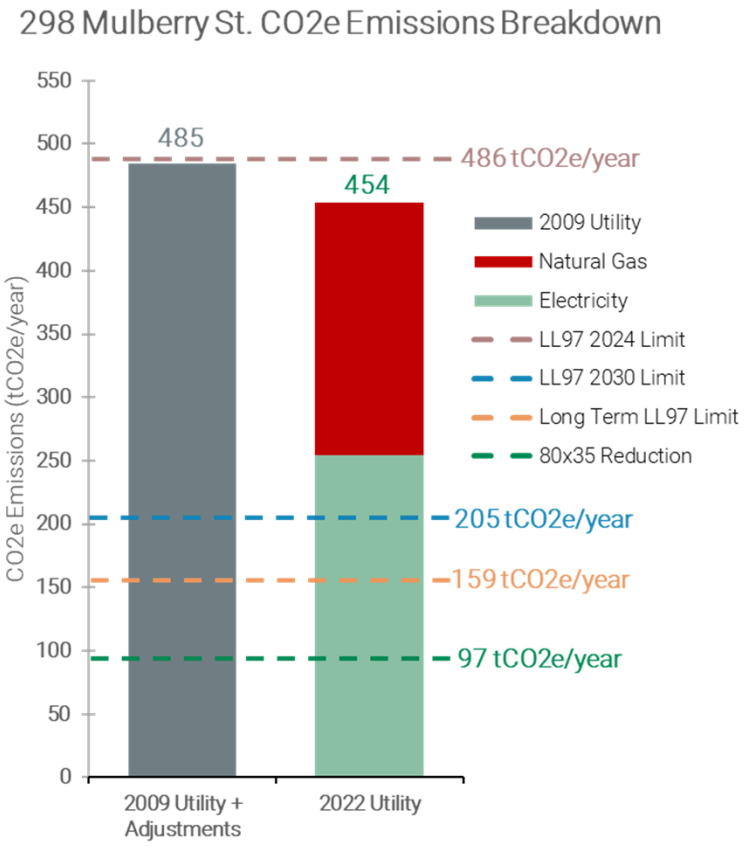
298 Mulberry Current Status for LL97 and 80x35 Challenge



Key Takeaways:

- Building meets 2024 Limit of 486 tCO_2e/year
- 54.9% reduction required to meet 2030 Limit of 205 tCO_2e/year
- 65.0% reduction is required to meet LL97 2035 target
- 78.7% reduction is required to meet ESRT 80x35 goal.

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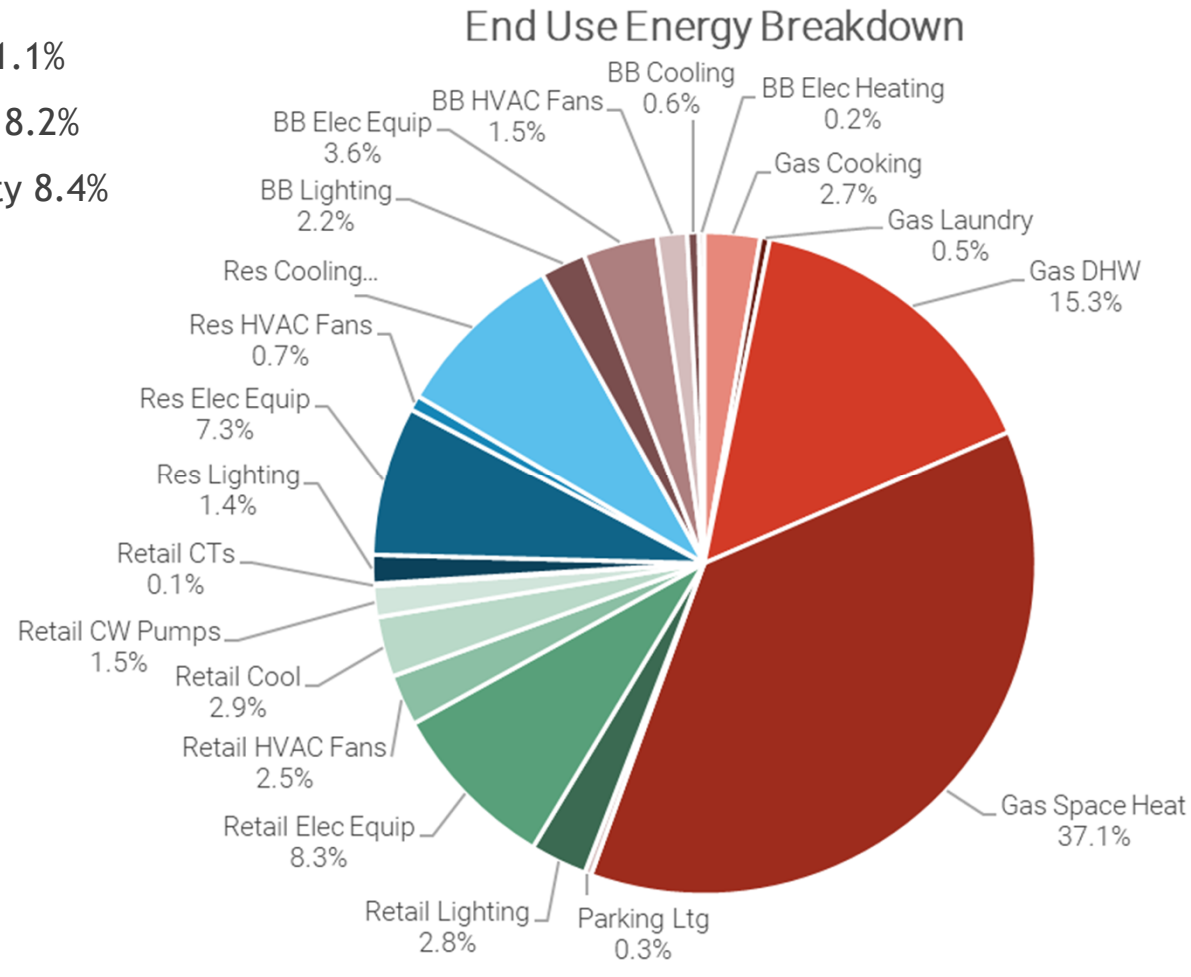
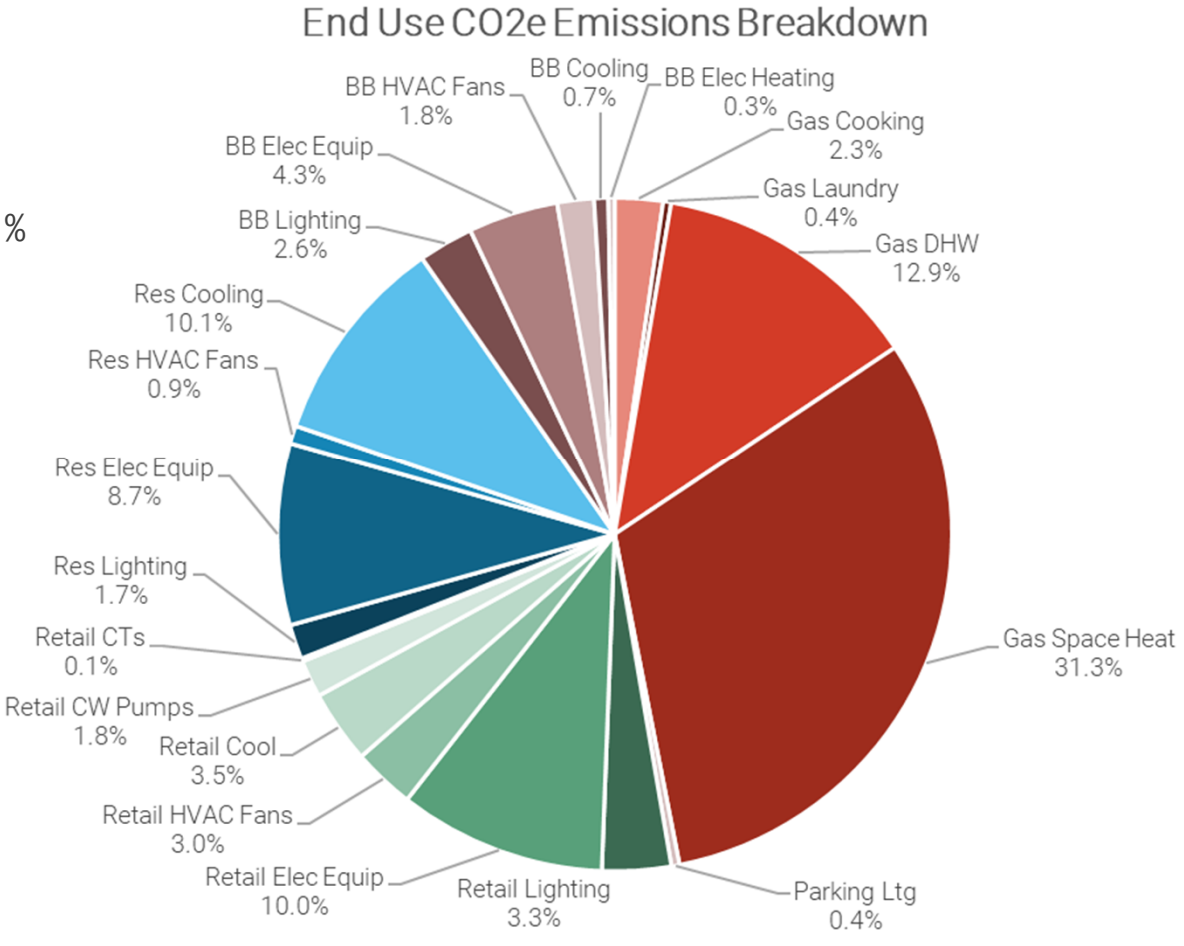
298 Mulberry Energy Model: 2019 Energy Breakdown

- Residential Tenants ~21.1%
- Retail Tenants (CVS) ~18.2%
- Base Building Electricity 8.4%
- Space Heating 37.1%
- DHW 15.3%



298 Mulberry Energy Model: 2019 CO_2e Emissions Breakdown

- Residential Tenants ~24.0%
- Retail Tenants (CVS) ~21.7%
- Base Building Electricity 10.1%
- Space Heating 31.3%
- DHW 12.9%



298 Mulberry Case Study

Baseline Energy Modeling
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ECM Packages – Recommended Package is CO_2 Mid

Four packages of ECMs were developed to optimize NPV and CO_2 reductions, highest impact ECMs listed

1

CO_2 Light

Space Heat Partial Electrification: PTHP for Apartment heat and ERV

2

CO_2 Mid

Space Heat Full Electrification and ERV (except retail)

Domestic Hot Water Heating Electrification - 80%

3

CO_2 High

Space Heat Full Electrification and ERV

Domestic Hot Water Heating Electrification - 80%

CVS (Tenant) Electrification

4

CO_2 Max

Space Heat Full Electrification and ERV

Domestic Hot Water Heating Electrification - 93%

CVS (Tenant) Electrification

Carbon Reduction

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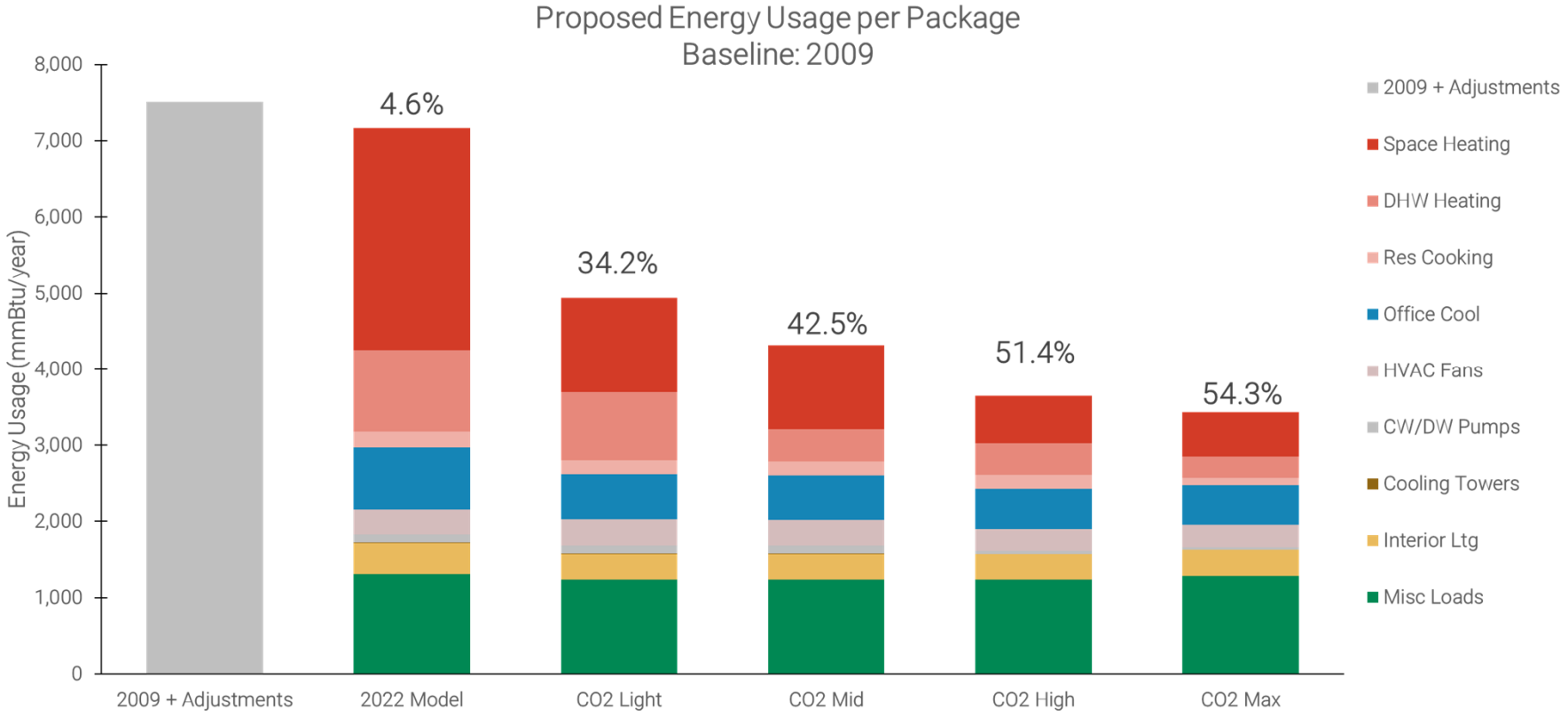
ECM Phases & Implementation Timeline: CO_2 Mid

ENERGY CONSERVATION MEASURES (ECMS)			IMPLEMENTATION TIMELINE												
Phase	**Tag**	**Description**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**
Phase 1	AS003	Replace rooftop exhaust fans not connected to ERV	0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Phase 1	CO002	Demand controlled ventilation in public spaces	0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Phase 1	DW002	Reduce laundry hot water temperatures	0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Phase 1	EN04	Lobby entrance seals	0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Phase 1	TL01	LED Fixture Replacement	0%	0%	50%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Phase 2	AS001	Exhaust/Supply Energy Recovery	0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Phase 2	EL01	Change All AC TO HP in Amenity Spaces	0%	0%	0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Phase 2	TL03	Replace Condensing Dryers with heat pump dryers	0%	50%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Phase 2	EL06	Domestic Hot Water Electrification – 80%	0%	0%	0%	0%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Phase 3	DW001	Low flow fixtures	0%	0%	20%	40%	60%	80%	100%	100%	100%	100%	100%	100%	100%
Phase 3	TL02	Energy Efficient Appliances	0%	17%	33%	50%	67%	83%	100%	100%	100%	100%	100%	100%	100%
Phase 3	AS004	Replace PTAC with PTHP	0%	20%	40%	60%	80%	100%	100%	100%	100%	100%	100%	100%	100%

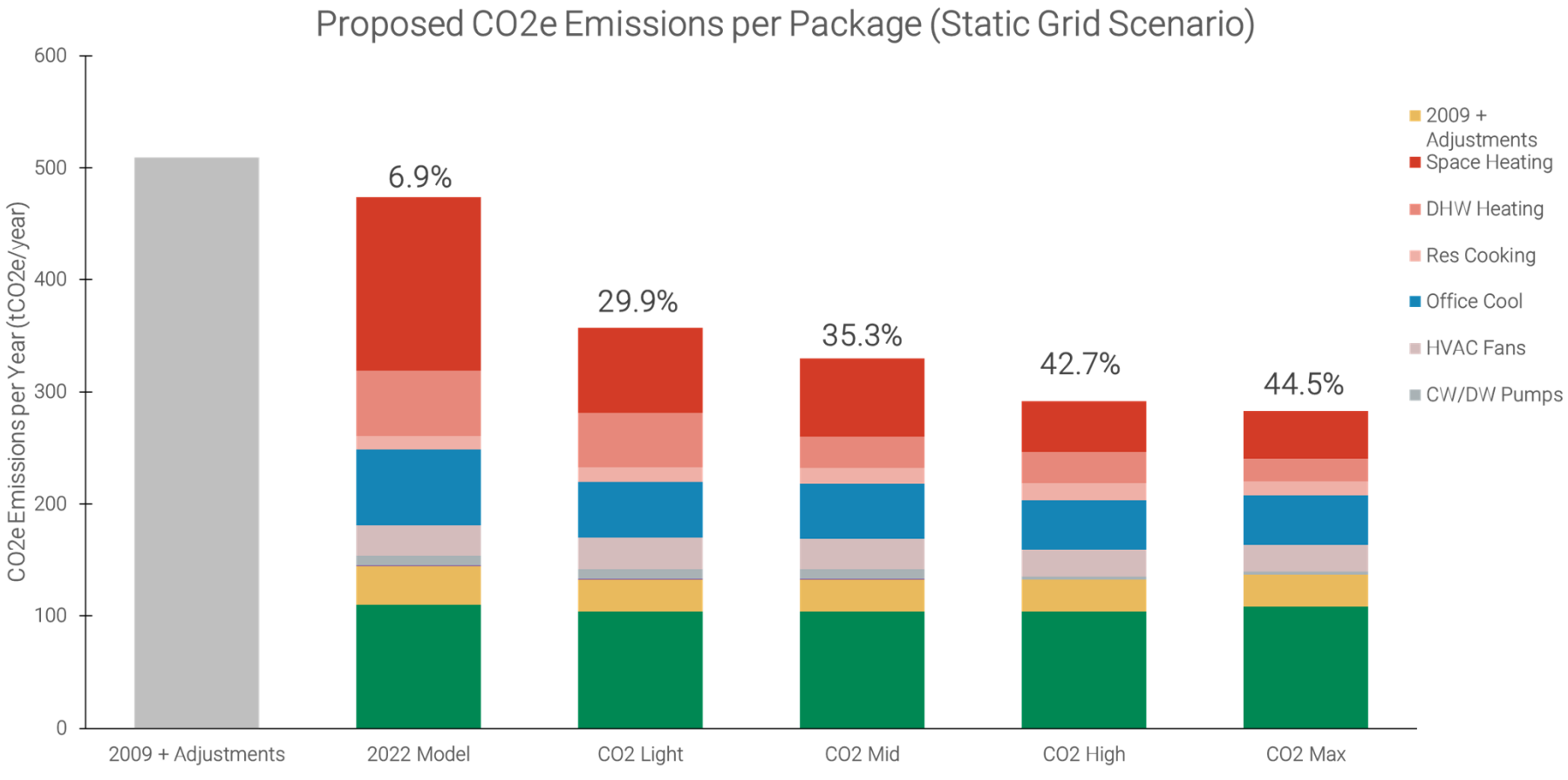
298 Mulberry ECM Package Comparison: Energy

Baseline: 2009



Notes:
2009 + Adjustments are estimated from 2022 energy use with adjustments from building improvements (lighting and window replacements in 2017)

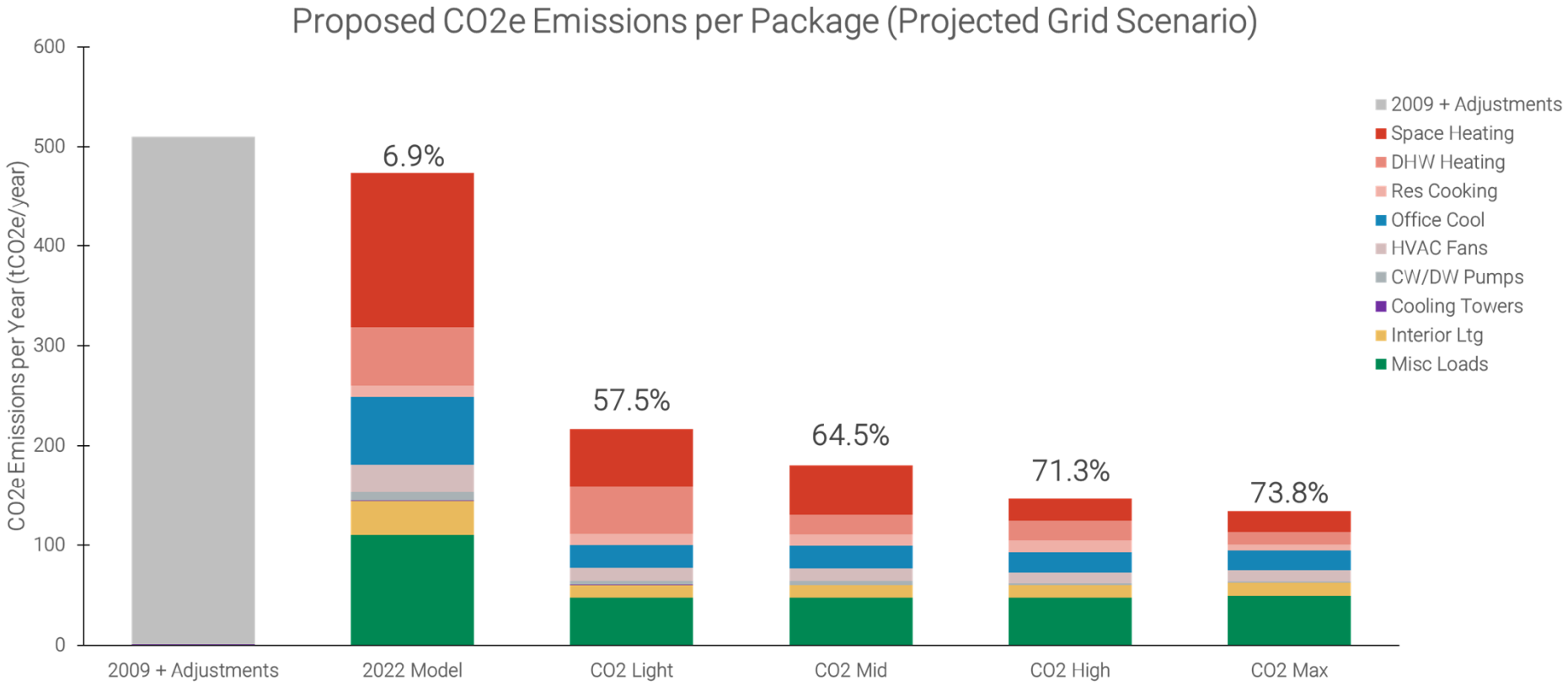
Projected CO_2 Emissions: Static 2019 Grid Scenario



Notes:
2009 + Adjustments are estimated from 2022 energy use with adjustments from building improvements (lighting and window replacements in 2017) and with 2009 electricity grid factors

Projected CO_2 Emissions: Projected Grid Scenario

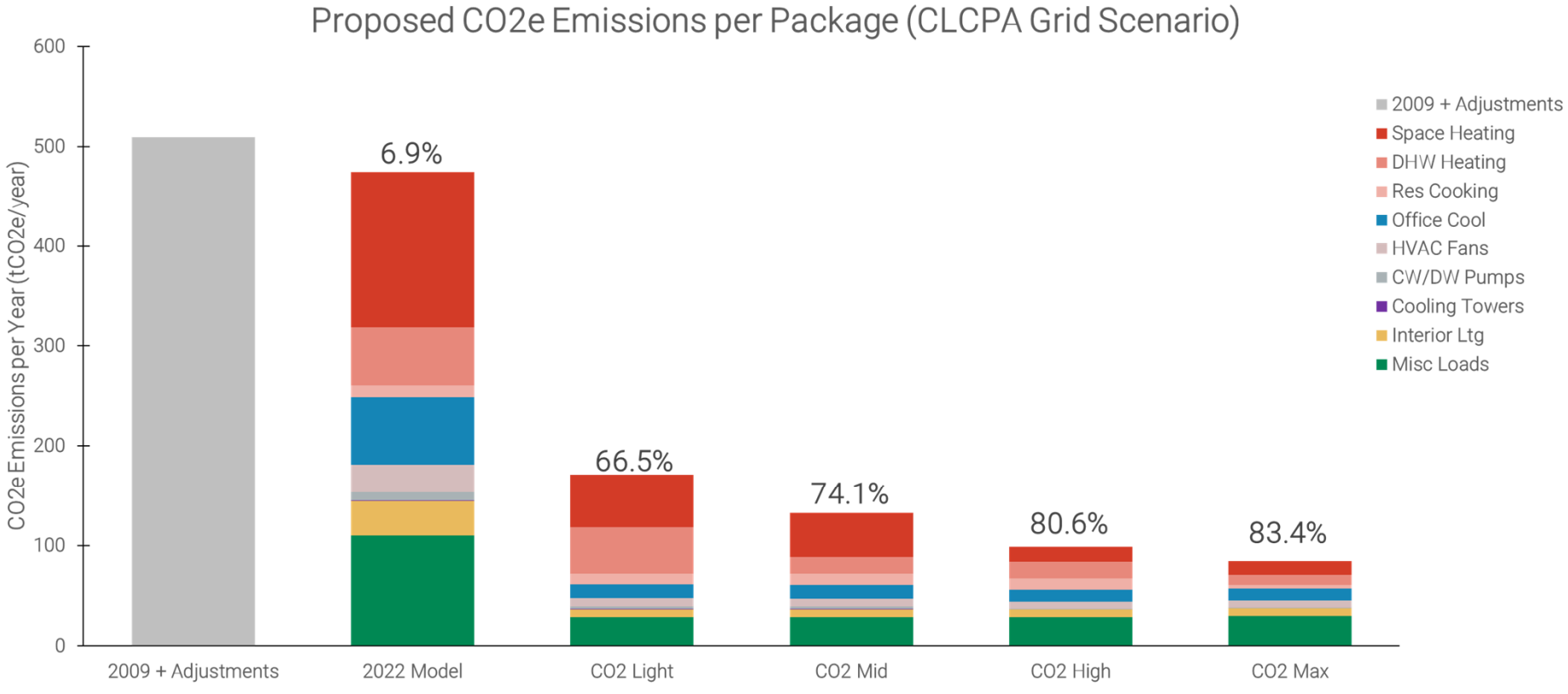
The graph shows projected savings for each package in 2035



Notes:
2009 + Adjustments are estimated from 2022 energy use with adjustments from building improvements (lighting and window replacements in 2017) and with 2009 electricity grid factors

Projected CO_2 Emissions: CLCPA Grid Scenario

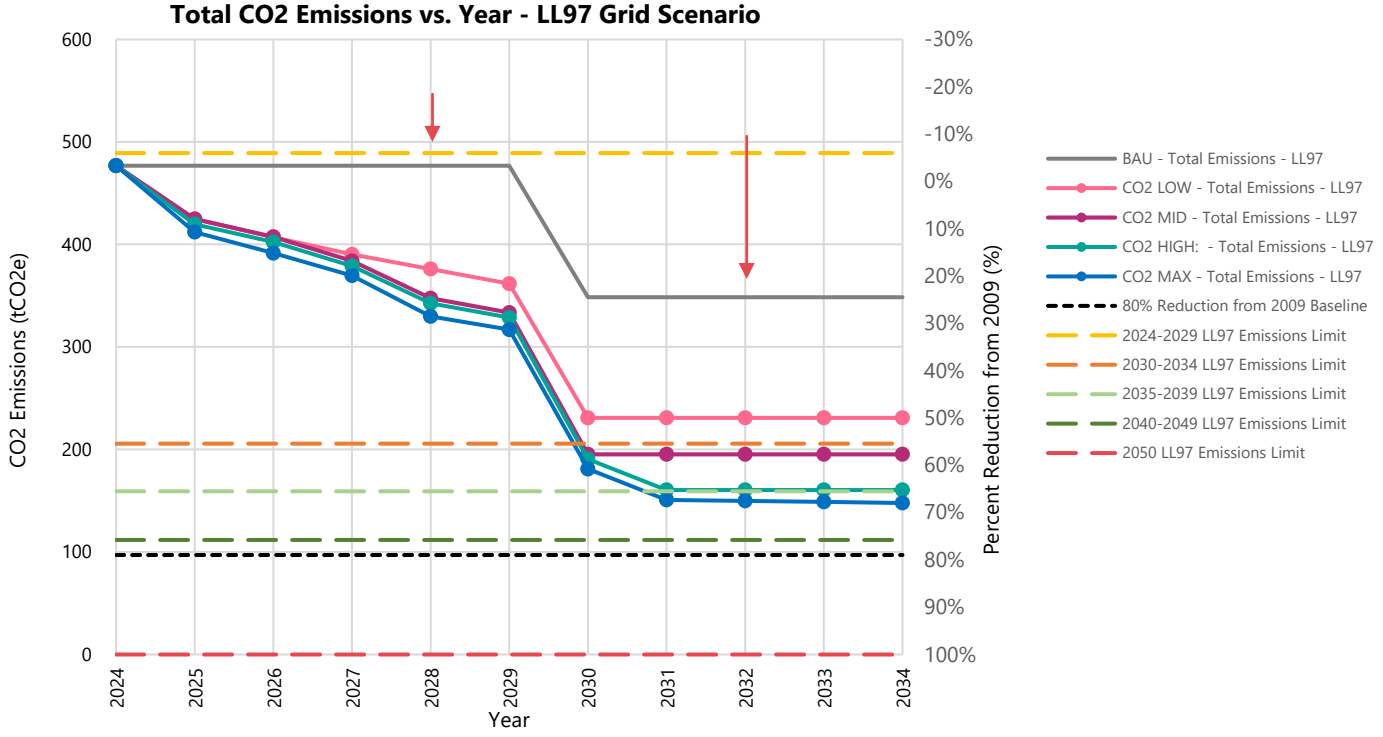
The graph shows projected savings for each package in 2035



Notes:
2009 + Adjustments are estimated from 2022 energy use with adjustments from building improvements (lighting and window replacements in 2017) and with 2009 electricity grid factors

Projected Annual Carbon Emissions – LL97 Compliance

Current 2022 baseline & all packages are below 2024-2029 LL97 emissions limit; CO2 Mid, High & Max packages are below 2030-2034 limits



1. 2035-2039 and 2040-2049 limits are shown for reference only. Compliance cannot be confirmed until GHG emissions coefficients for those periods are released.
2. 80% Reduction from 2009 Baseline are estimated from 2022 energy use to 2009 emission coefficients

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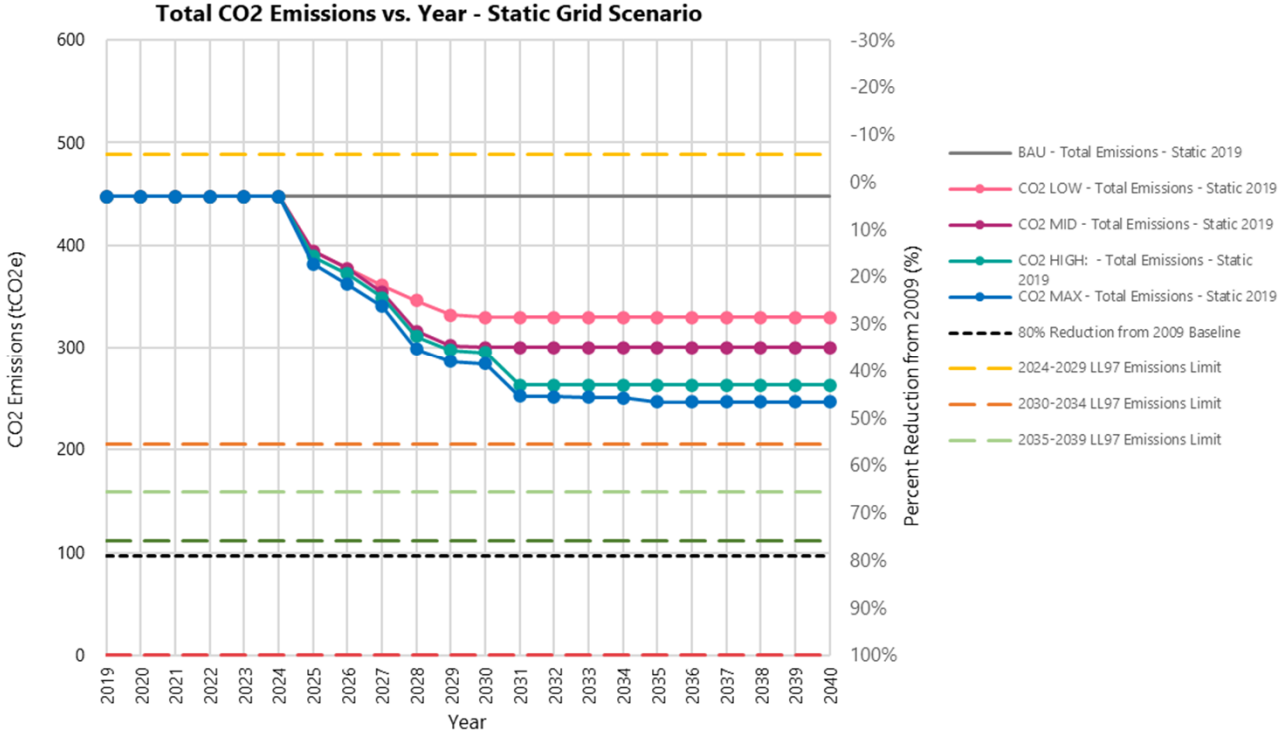
Projected Annual Carbon Emissions – Static 2019 Grid Scenario

No packages would meet **80% reduction** from 2009 baseline by **2035** without grid decarbonization;
No packages would meet **2040 -2049 LL97 Emissions Limit** without grid decarbonization



1. 2035-2039 and 2040-2049 limits are shown for reference only. Compliance cannot be confirmed until GHG emissions coefficients for those periods are released.
2. 80% Reduction from 2009 Baseline are estimated from 2022 energy use to 2009 emission coefficients

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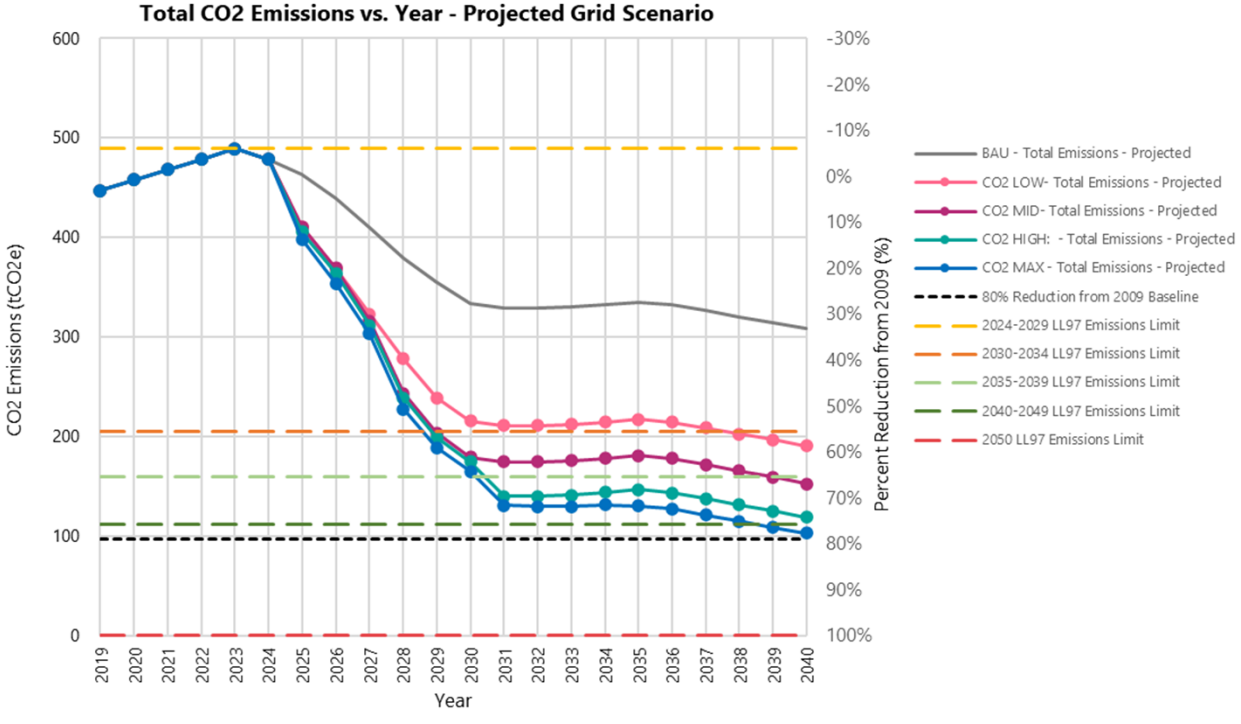
Projected Annual Carbon Emissions – Projected Grid Scenario

No packages would meet **80% reduction** from 2009 baseline by **2035**;
CO2 High and Max meet **2040 -2049 LL97 Emissions Limit**



1. 2035-2039 and 2040-2049 limits are shown for reference only. Compliance cannot be confirmed until GHG emissions coefficients for those periods are released.
2. 80% Reduction from 2009 Baseline are estimated from 2022 energy use to 2009 emission coefficients

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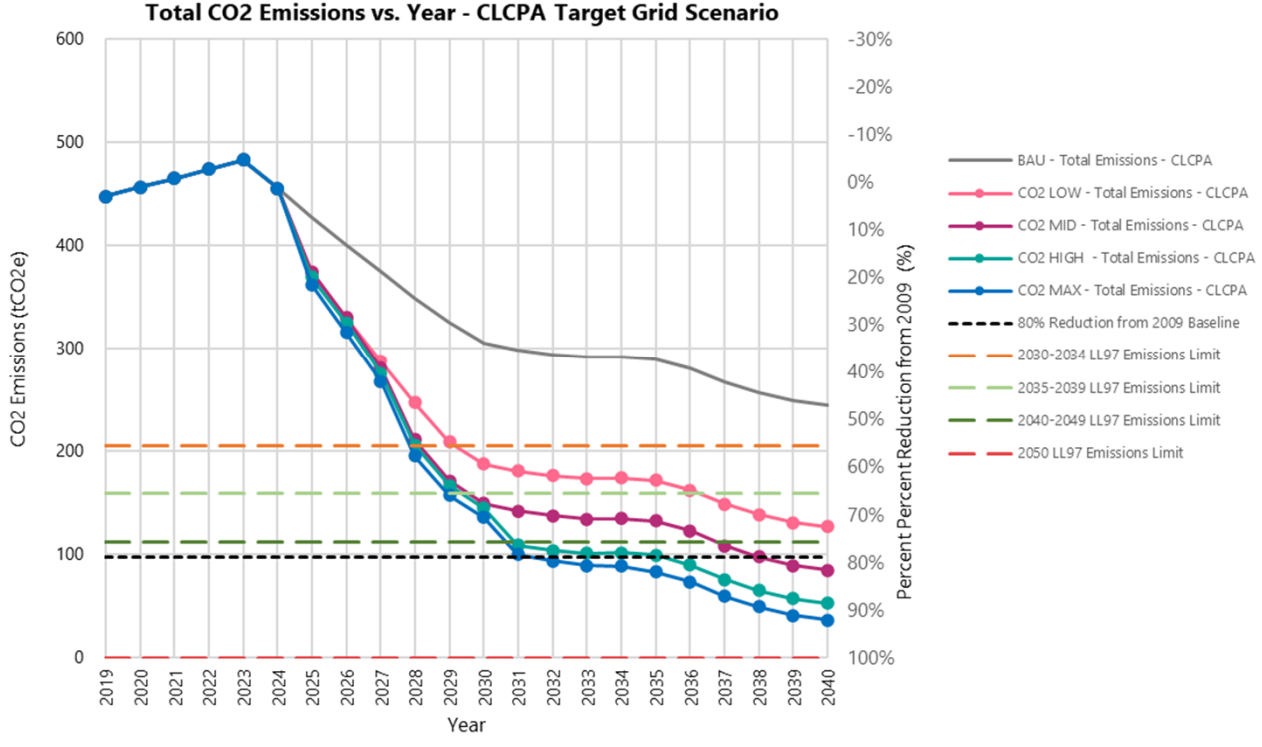
Projected Annual Carbon Emissions – CLCPA Grid Scenario

CO_2 Max High meet **80% reduction** from 2009 baseline by **2035**;
CO_2 Max, High and Mid would meet **average long-term LL97 limits**



1. 2035-2039 and 2040-2049 limits are shown for reference only. Compliance cannot be confirmed until GHG emissions coefficients for those periods are released.
2. 80% Reduction from 2009 Baseline are estimated from 2022 energy use to 2009 emission coefficients

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Percent Carbon Emissions Reductions – All Grid Scenarios

80x35 target based on reductions from 2009 baseline
Reductions from 2022 baseline show impact of packages compared to current usage

STATIC GRID SCENARIO

	2022 - 2030	2022 - 2035	**2009 - 2030**	**2009 - 2035**
MAX	-36.5%	-44.9%	**-41.4%**	**-49.2%**
HIGH	-34.0%	-41.2%	**-39.1%**	**-45.8%**
MID	-32.9%	-32.9%	**-38.1%**	**-38.1%**
LOW	-26.3%	-26.3%	**-32.0%**	**-32.0%**

No packages would meet **80% reduction** from 2009 baseline by 2035 or the **2035 LL97 emission limit**

PROJECTED GRID SCENARIO

	2022 - 2030	2022 - 2035	**2009 - 2030**	**2009 - 2035**
MAX	-63.1%	-70.9%	**-65.9%**	**-73.1%**
HIGH	-61.0%	-67.2%	**-64.0%**	**-69.7%**
MID	-60.0%	-59.5%	**-63.1%**	**-62.7%**
LOW	-51.8%	-51.4%	**-55.5%**	**-55.1%**

No packages would meet **80% reduction** from 2009 baseline by **2035**;
CO_2 High and Max would meet the **2035 LL97 emission limit**

CLCPA TARGET GRID SCENARIO

	2022 - 2030	2022 - 2035	**2009 - 2030**	**2009 - 2035**
MAX	-69.6%	-81.4%	**-72.0%**	**-82.8%**
HIGH	-67.6%	-77.7%	**-70.1%**	**-79.5%**
MID	-66.6%	-70.3%	**-69.2%**	**-72.6%**
LOW	-58.1%	-61.6%	**-61.3%**	**-64.5%**

CO_2 High and Max would meet **80% reduction** from 2009 baseline by **2035,** CO_2 Mid by 2038;
All packages except CO_2 Light would meet the **2035 LL97 emission limit**

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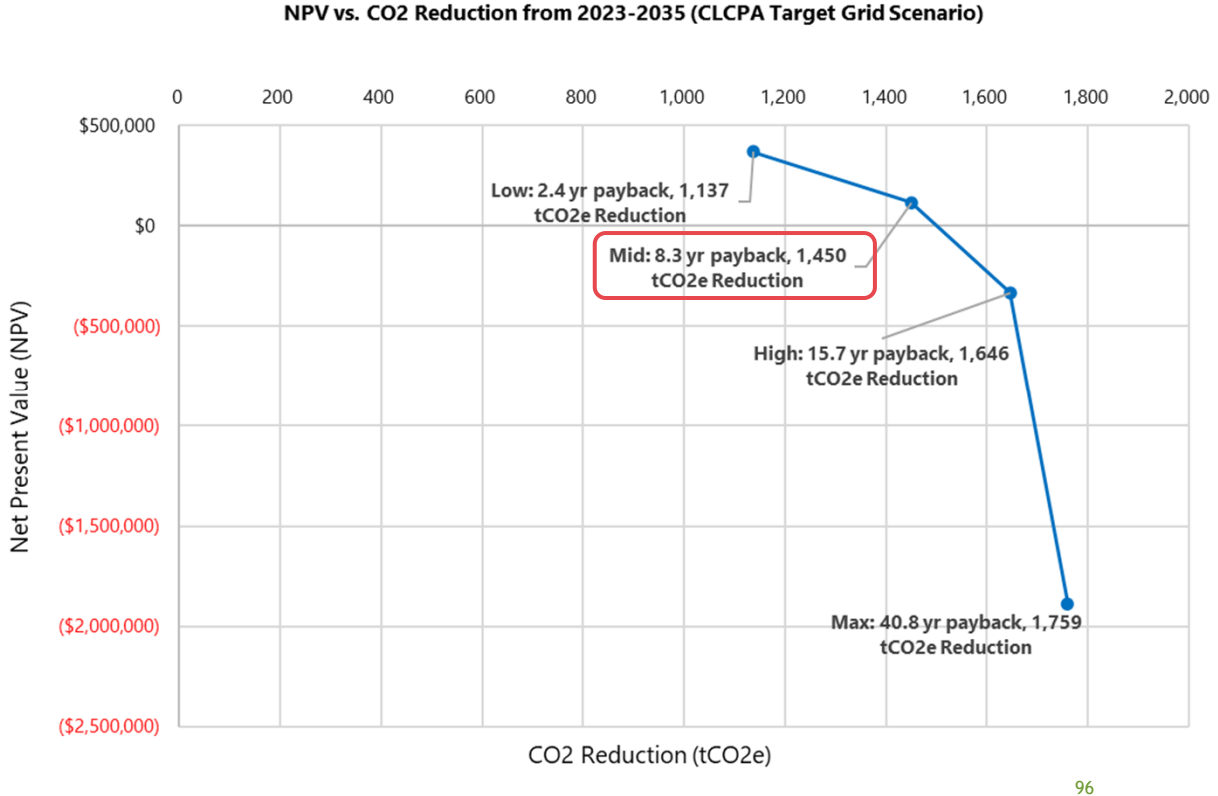
NPV, CO_2 Reductions and Simple Payback for all Packages

Recommended package CO_2 Mid is NPV positive from 2023-2035 and provides 28% greater carbon emissions reduction over study period compared to CO_2 Light



NPV calculated with 6% real discount rate

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Projected LL97 Fines From 2024-2034

No LL97 fines projected for the baseline for 2024-2029;
Fines possible from 2030-2034 for baseline and Low package, though all packages offset the potential fines.

Packages	LL97 Fines From 2024-2034		
	2022 Emissions Limits		
	Total Fine From 2024-2029	Total Fine From 2030-2034	Fine Avoidance From 2024-2034
BAU (2019 Consumption)	$0	$191,474	-
Low	$0	$33,729	$157,746
Mid	$0	$0	$191,474
High	$0	$0	$191,474
Max	$0	$0	$191,474

1. 2022 emissions limits are calculated using the building emissions factors provided in the LL97 rules, which are based on Energy Star property types.
2. Fine calculations for 2024-2029 and 2030-2034 are based on GHG coefficients provided in LL97 of 2022.

Projected LL97 Fines From 2035-2050 Based on Projected Grid Scenario

Fines possible from 2035-2049 for baseline and all packages except Max, though CO_2 High and Mid offset most of the potential fines.

Packages	Projected LL97 Fines From 2035-2050 Based on Projected Grid Scenario				
	2022 Emissions Limits				
	Total Fine From 2035-2039	Total Fine From 2040-2049	Total Fine From 2035-2049	Fine Avoidance From 2035-2049	Annual Fine From 2050 Onward
BAU (2019 Consumption)	$223,364	$474,299	$697,663	-	$75,144
Low	$65,557	$158,480	$224,037	$473,626	$43,557
Mid	$16,006	$53,374	$69,379	$628,283	$32,913
High	$0	$2,303	$2,303	$695,360	$24,074
Max	$0	$0	$0	$697,663	$19,728

1. 2022 emissions limits are calculated using the building emissions factors provided in the LL97 rules, which are based on Energy Star property types.
2. Fine calculations for 2024-2029 and 2030-2034 are based on GHG coefficients provided in LL97 of 2022.

Projected LL97 Fines From 2035-2050 Based on CLCPA Grid Scenario

Fines possible from 2035-2049 for baseline and low package, CO_2 Mid, High, and Max packages offset the fines.

Packages	Projected LL97 Fines From 2035-2050 Based on CLCPA Grid Scenario				
	2022 Emissions Limits				
	Total Fine From 2035-2039	Total Fine From 2040-2049	Total Fine From 2035-2049	Fine Avoidance From 2035-2049	Annual Fine From 2050 Onward
BAU (2019 Consumption)	$146,612	$330,205	$476,817	-	$62,034
Low	$4,364	$14,092	$18,456	$458,361	$30,421
Mid	$0	$0	$0	$476,817	$18,988
High	$0	$0	$0	$476,817	$10,482
Max	$0	$0	$0	$476,817	$6,172

1. 2022 emissions limits are calculated using the building emissions factors provided in the LL97 rules, which are based on Energy Star property types.
2. Fine calculations for 2024-2029 and 2030-2034 are based on GHG coefficients provided in LL97 of 2022.

Financial & Carbon Summary - Recommended Package is CO_2 Mid

Meets 80x35 Target (CLCPA Grid, Y/N)	CO_2 Light (N)	CO_2 Mid (N)	CO_2 High (Y)	CO_2 Max (Y)
Carbon Emissions in 2035 [tCO2e] (CLCPA Grid)[3]	172	23% Decrease → 133	100	83
NPV (2023-2035)[1]	$367,824	$115,111	($332,346)	($1,888,074)
NPV (Asset Life)[1]	$489,303	$289,778	($102,191)	($1,888,626)
Base Capital Cost[2]	($2,052,399)	($2,470,844)	($2,470,844)	($2,695,206)
Incremental Capital Cost[2]	($414,597)	($861,303)	($1,678,518)	($4,037,432)
Total Capital Cost[2]	($2,466,996)	($3,332,147)	($4,149,362)	($6,732,638)
Landlord Annual Energy Cost Savings[2]	$52,045	17% Increase → $60,828	$77,305	$86,540
Tenant Annual Energy Cost Savings[2]	$1,384	$1,302	$1,624	($746)
Annual Repairs & Maintenance Savings	$840	$840	$840	$840
Incentives	$286,700	$352,171	$447,993	$473,417
Landlord Payback [yrs]	**2.4**	**8.3**	**15.7**	**40.8**

CO2 Light: Install Energy Recovery (ERV) for corridor ventilation, replace aging fans, replace PTAC with PTHP in apartments, demand-controlled ventilation in fitness room, reduce laundry hot water temperature, repair lobby entrance door seals, corridor LED fixture replacement, replace condensing clothes dryers with heat pump dryers, install low flow shower heads, install high energy efficient appliances
CO2 Mid: CO2 Light + change all AC to HP in amenity spaces, install partial domestic hot water electrification (80%)
CO2 High: CO2 Mid + plus install garage roll-up door and electrify CVS steam coil ceiling hung AC units
Notes:

1. NPV calculated with 6% real discount rate
2. Base and incremental capital costs listed are based on current cost estimates and excludes future construction escalation costs. Annual energy cost savings listed are based on current 2023 estimates and exclude benefit from future utility cost escalations.
3. Carbon emissions in 2035 (annual, not cumulative) based on CLCPA grid.

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Landlord and Tenant energy savings – Recommended Package CO2 Mid

Energy Conservation Measure	Tenant	Landlord
	Electricity Annual Savings	Natural Gas Annual Savings
AS004 Replace PTAC with PTHP	($7,108)	$32,227
TL002 Energy Efficient Appliances	$7,080	$0
TL03 Replace Condensing Dryers with heat pump dryers	$1,329	$0
Total Annual Savings	$1,302	$32,227
Total Annual Savings per Apartment (96 apt)	$13.56	$335.69

Recommended Package – CO_2 Mid

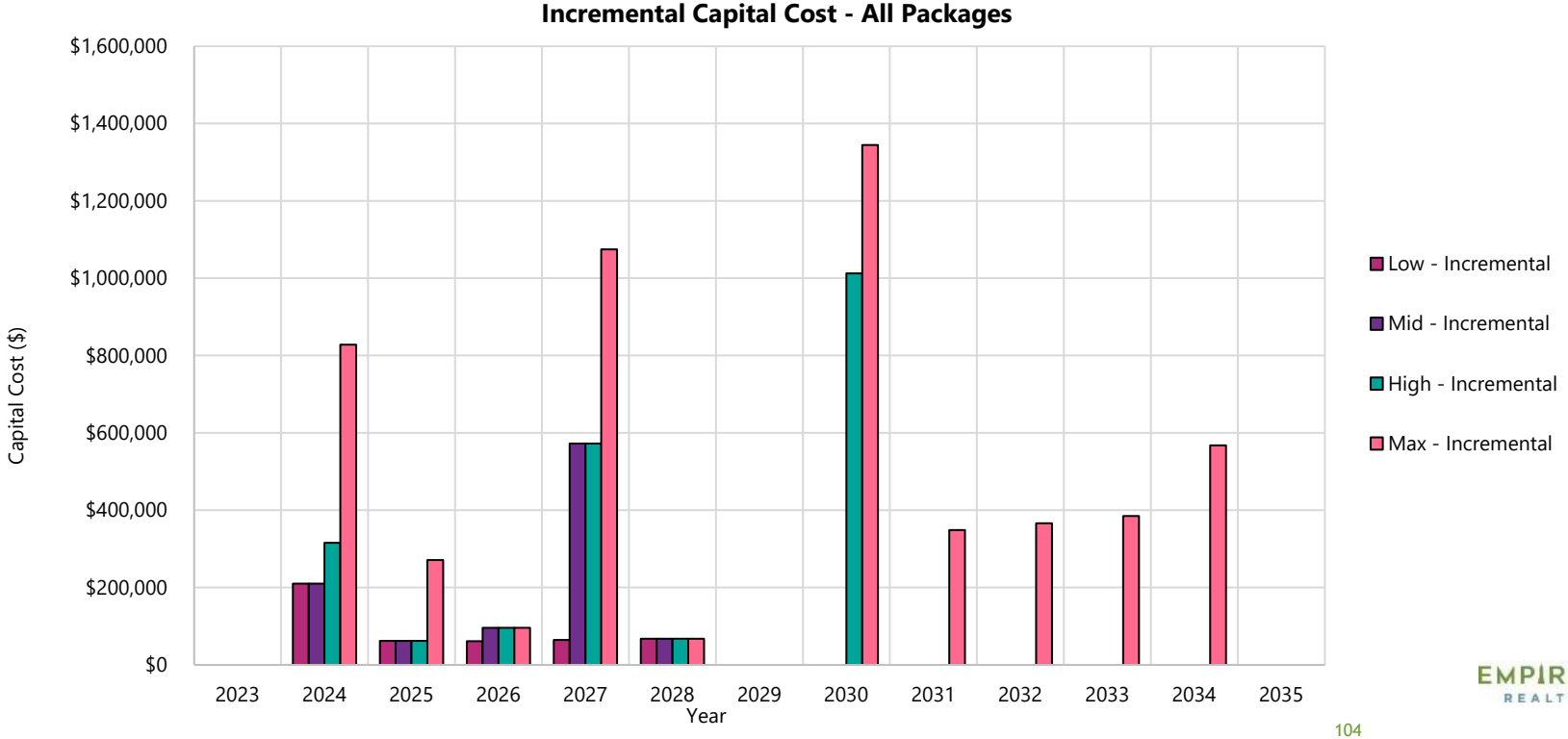
- Meets LL 97 2030-2034 targets, meets ESRT 80% reduction with CLCPA grid by 2038
- Implements critical upgrades including corridor conditioned outdoor air with ERV
- Replaces aging fans original to the building (~37 years) with high efficiency ECM motor fans
- Incorporates planned improvements such as corridor lighting (original to the building). Interim LED re-lamping is completed, corridor refresh planned in CapEx.
- ECMs that contribute to large CO2 emission reductions are related to electrification for space heating/cooling and domestic hot water:
  - EL01 Change all AC to heat pumps in amenity spaces
  - AS05 Replace apartment PTAC units with PTHP
  - EL06 Domestic hot water partial electrification (80%)

298 Mulberry Case Study

Baseline Energy Modeling
ECM Phasing and Packaging
Energy and Carbon Emissions Results
Financial Analysis and Recommendations
Capital Expenditure and Budget

Annual Incremental Capital Cost per Package

Capital investments and improvements are planned in the first 5 years to meet LL97 limits by 2030
Partial Domestic Hot Water electrification is planned for 2027 after hot water efficiency measures are in place or more than half-way through completion



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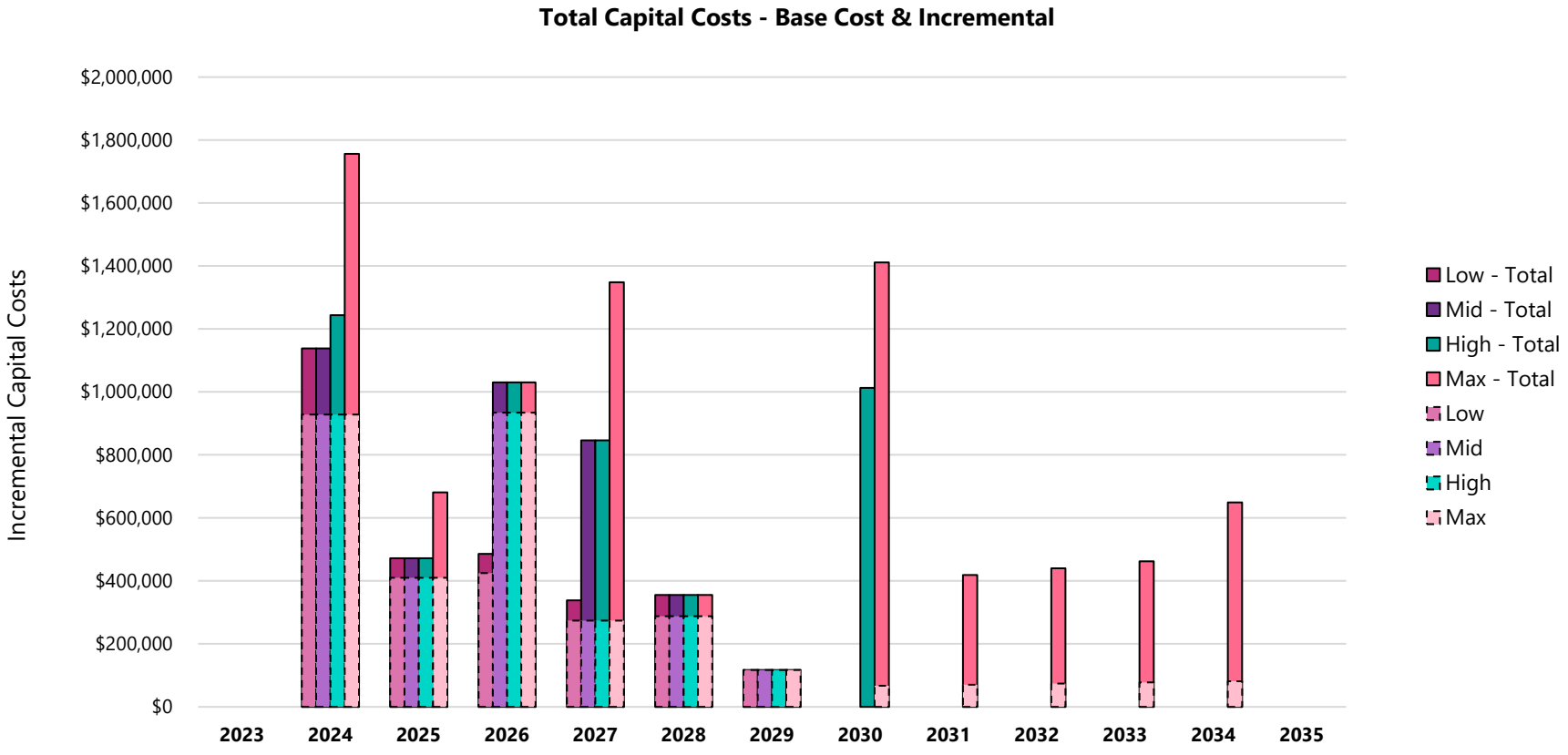
Annual Incremental Capital Cost vs. Base Cost per Package



Notes:
Base costs include corridor ventilation air supply, existing amenity space heating/cooling unit replacement, PTAC unit replacements (~37 years), aging fan replacements, corridor lighting renovation, planned apartment appliance upgrades, entrance door seal repair

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298 Mulberry Next Steps – 2024 Projects

The recommended 2024 measures are focused on improving ventilation efficiencies in general areas and electrifying apartment heating along with base building efficiencies, 4.2 year payback

Project	Base Cost ($)	Incremental Cost ($)	Total Cost ($)	Anticipated Incentives ($)	Total Cost w/ Incentives ($)	Landlord Energy Cost Savings ($)
Replace rooftop exhaust fans not connected to ERV	($79,934)	($14,180)	($94,114)	$3,125	($90,989)	$2,032
Demand Controlled ventilation in public spaces	$0	($17,620)	($17,620)	$2,776	($14,841)	$2,144
Reduce Laundry Hot Water Temperatures	$0	($25,737)	($25,737)	$1,404	($24,333)	$1,507
Lobby entrance door seal repair	($14,188)	$0	($14,188)	$634	($13,554)	$1,096
Replace Condensing Dryers with Heat Pump Dryers[1]	($5,519)	($3,241)	($9,039)	$0	($8,760)	$0
Exhaust/Supply Energy Recovery	($599,618)	($93,721)	($693,339)	$44,585	($648,754)	$10,020
Energy Efficient Appliances[1]	($83,727)	$0	($83,727)	$2,741	($67,283)	$1,791
Replace PTAC with PTHP[1]	($144,794)	($55,567)	($200,361)	$40,496	($159,865)	$8,330
Total Budget	**($927,780)**	($210,066)	**($1,137,846)**	**$95,761**	**($1,042,085)**	**$26,913**

Notes:
1. Includes implementation costs, incentives and savings in 2024. Refer to Appendix for ECM implementation 2024-2034.

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Appendix

298 Mulberry Financial Analysis: Recommended Package – CO2 Mid

Meets 80x35 Target (CLCPA Grid, Y/N)	CO_2 Light (N)	CO_2 Mid (N)	CO_2 High (Y)	CO_2 Max (Y)
Carbon Emissions in 2035 [tCO2e] (CLCPA Grid)[3]	172	133	100	83
NPV (2023-2035)	$367,824	$115,111	($332,346)	($1,888,074)
NPV (Asset Life)	$489,303	$289,778	($102,191)	($1,888,626)
Total Base Cost	($2,052,399)	($2,470,844)	($2,470,844)	($2,695,206)
➢ Landlord Base Cost	($2,052,399)	($2,470,844)	($2,470,844)	($2,695,206)
➢ Tenant Base Cost	$0	$0	$0	$0
Incremental Capital Cost	($414,597)	($861,303)	($1,678,518)	($4,037,432)
➢ Landlord Incremental Capital Cost	($414,597)	($861,303)	($1,678,518)	($4,037,432)
➢ Tenant Incremental Capital Cost	$0	$0	$0	$0
Annual Energy Cost Savings	$53,429	$62,130	**$78,929**	$85,794
➢ Landlord Annual Energy Cost Savings	$52,045	$60,828	**$77,305**	$86,540
➢ Tenant Annual Energy Cost Savings	$1,384	$1,302	$1,624	($746)
Annual Repairs & **Maintenance** Savings	$840	$840	$840	$840
Incentives	$286,700	$352,171	$447,933	$473,417
➢ Landlord Incentives	$286,700	$352,171	$447,933	$473,417
➢ Tenant Incentives	$0	$0	$0	$0
Simple Payback	2.4	8.1	15.4	41.1
➢ Landlord Simple Payback	**2.4**	**8.3**	**15.7**	**40.8**
➢ Tenant Simple Payback	N/A	N/A	N/A	N/A

29% decrease

16% increase

Notes:
1. NPV calculated with 6% real discount rate
2. Base and incremental capital costs listed are based on current cost estimates and excludes future construction escalation costs. Annual energy cost savings listed are based on current 2023 estimates and exclude benefit from future utility cost escalations.

The Victory Financial Analysis: Recommended Package – CO2 Mid

Meets 80x35 Target (CLCPA Grid, Y/N)	CO_2 Light (N)	CO_2 Mid (N)	CO_2 High (Y)	CO_2 Max (Y)
Carbon Emissions in 2035 [tCO2e] (CLCPA Grid)[3]	806	456	453	197
NPV (2023-2035)	$1,162,015	$871,356	$542,241	($4,154,179)
NPV (Asset Life)	$3,089,903	$2,808,902	$2,383,963	($3,505,276)
Total Base Cost	($3,488,371)	($4,465,861)	($4,465,861)	($2,421,572)
➢ Landlord Base Cost	($3,488,371)	($4,465,861)	($4,465,861)	($5,859,984)
➢ Tenant Base Cost	$0	$0	$0	$0
Incremental Capital Cost	($4,186,130)	($5,316,271)	($5,852,787)	($38,048,862)
➢ Landlord Incremental Capital Cost	($4,186,130)	($5,316,271)	($5,852,787)	($38,048,862)
➢ Tenant Incremental Capital Cost	$0	$0	$0	$0.00
Annual Energy Cost Savings	$87,162	$103,083	$102,753	$176,687
➢ Landlord Annual Energy Cost Savings	$231,617	$250,325.35	$250,751	$312,414
➢ Tenant Annual Energy Cost Savings	($144,455)	($147,242)	($147,998)	($135,727)
Annual Repairs & **Maintenance** Savings	$3,000	$3,000	$3,000	$3,000
Incentives	$2,688,848	$3,425,212	$3,450,201	$4,350,888
➢ Landlord Incentives	$2,688,848	$352,171	$447,933	$4,350,888
➢ Tenant Incentives	$0	$0	$0	$0
Simple Payback	16.6	17.8	22.7	187.5
➢ Landlord Simple Payback	6.4	7.5	9.5	106.8
➢ Tenant Simple Payback	N/A	N/A	N/A	N/A

43% decrease

18% increase

Notes:
1. NPV calculated with 6% real discount rate
2. Base and incremental capital costs listed are based on current cost estimates and excludes future construction escalation costs. Annual energy cost savings listed are based on current 2023 estimates and exclude benefit from future utility cost escalations.

The Chesapeake Financial Analysis: Recommended Package – CO2 Mid

Meets 80x35 Target (CLCPA Grid, Y/N)	CO_2 Light (N)	CO_2 Mid (N)	CO_2 High (Y)	CO_2 Max (Y)
Carbon Emissions in 2035 [tCO2e] (CLCPA Grid)[3]	440	52% decrease → 288	233	197
NPV (2023-2035)	$58,609	($11,643)	($894,108)	($4,154,179)
NPV (Asset Life)	$408,178	$656,401	($48,216)	($3,505,276)
Total Base Cost	($685,096)	($1,075,376)	($1,837,986)	($2,421,572)
➢ Landlord Base Cost	($685,096)	($1,075,376)	($1,837,986)	($2,421,572)
➢ Tenant Base Cost	$0	$0	$0	$0
Incremental Capital Cost	($2,625,786)	($3,489,283)	($5,121,341)	($9,929,906)
➢ Landlord Incremental Capital Cost	($2,625,786)	($3,489,283)	($5,121,341)	($9,929,906)
➢ Tenant Incremental Capital Cost	$0	$0	$0	$0
Annual Energy Cost Savings	$100,393	$145,844	$182,467	$208,591
➢ Landlord Annual Energy Cost Savings	$216,498	19% increase → $259,281	$278,432	$297,841
➢ Tenant Annual Energy Cost Savings	($116,105)	($113,438)	($95,965)	($89,250)
Annual Repairs & **Maintenance** Savings	$0	$840	$840	$840
Incentives	$877,037	$1,224,707	$1,439,912	$1,676,751
➢ Landlord Incentives	$877,037	$1,224,707	$1,439,912	$1,676,751
➢ Tenant Incentives	$0	$0	$0	$0
Simple Payback	17.4	15.4	20.1	39.4
➢ Landlord Simple Payback	**8.1**	**8.7**	**13.2**	**27.6**
➢ Tenant Simple Payback	N/A	N/A	N/A	N/A

Notes:
1. NPV calculated with 6% real discount rate
2. Base and incremental capital costs listed are based on current cost estimates and excludes future construction escalation costs. Annual energy cost savings listed are based on current 2023 estimates and exclude benefit from future utility cost escalations.

298 Mulberry – Future Base Building Projects (4 years, 2025-2029)

Project	Base Cost ($)	Incremental Cost ($)	Total Cost ($)	Anticipated Incentives ($)	Total Cost w/ Incentives ($)	Annual Landlord Energy Cost Savings ($)
LED Fixture Replacement 2025-2026	($319,869)	($0)	($319,869)	$10,713	($309,156)	$6,323
Change All AC to HP in Amenity Spaces 2026	($509,786)	($34,581)	($544,367)	$29,575	($514,792)	$2,534
Domestic Hot Water Partial Electrification – 80% 2027	$0	($507,886)	($507,886)	$36,440	($471,446)	$6,540
Total Budget	**($829,655)**	**($542,467)**	**($1,372,122)**	**$76,728**	**($1,295,394)**	**$15,397**

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298 Mulberry - Tenant Projects

Projects to be completed at time of tenant roll-over and longer-term implementation

Replace Condensing Dryers with Heat Pump Dryers	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Total Capital Costs	($8,760)	($9,203)										
Base Costs	($5,519)	($5,798)										
Incremental Costs (Total - Base)	($3,241)	($3,405)										
Incentives	$1,493	$1,493										
Tenant Energy Cost Savings		$1,006	$2,154	$2,258	$2,368	$2,482	$2,603	$2,730	$2,863	$3,006	$3,157	$3,317

Low Flow Fixtures	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Total Capital Costs		($7,837)	($8,234)	($8,650)	($9,088)	($9,548)	($7,837)					
Base Costs		($7,837)	($8,234)	($8,650)	($9,088)	($9,548)	($7,837)					
Incremental Costs (Total - Base)		$0	$0	$0	$0	$0	$0					
Incentives		$202	$202	$202	$202	$202	$202					
Landlord Energy Cost Savings			$452	$942	$1,484	$2,079	$2,731	$2,870	$3,015	$3,170	$3,334	$3,506

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298 Mulberry - Tenant Projects

Projects to be completed at time of tenant roll-over and longer-term implementation

Energy Efficient Appliances	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Total Capital Costs	($83,727)	($87,963)	($92,414)	($97,091)	($102,003)	($107,165)						
Base Costs	($83,727)	($87,963)	($92,414)	($97,091)	($102,003)	($107,165)						
Incremental Costs (Total - Base)	$0	$0	$0	$0	$0	$0						
Incentives	$2,741	$2,741	$2,741	$2,741	$2,741	$2,741						
Tenant Energy Cost Savings		$1,791	$3,837	$6,035	$8,435	$11,055	$13,907	$14,587	$15,295	$16,060	$16,868	$17,718

Replace PTAC with PTHP	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Total Capital Costs	($200,361)	($210,500)	($221,151)	($232,341)	($244,098)							
Base Costs	($144,794)	($152,121)	($159,818)	($167,905)	($176,401)							
Incremental Costs (Total - Base)	($55,567)	($58,379)	($61,333)	($64,436)	($67,697)							
Incentives	$40,496	$40,496	$40,496	$40,496	$40,496							
Landlord Energy Cost Savings		$8,330	$17,142	$26,595	$37,349	$49,153	$51,751	$54,481	$57,368	$60,385	$63,587	$66,946
Tenant Energy Cost Savings		($2,152)	($4,608)	($7,246)	($10,128)	($13,274)	($13,916)	($14,598)	($15,307)	($16,074)	($16,882)	($17,734)

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The Victory – Additional Base building projects (2-4 years)

Project	Base Cost ($)	Incremental Cost ($)	Total Cost ($)	Anticipated Incentives ($)	Total Cost w/ Incentives ($)	Annual Landlord Energy Cost Savings ($)
Change All AC to HP in Amenity Spaces 2026	($849,686)	($270,510)	($1,120,196)	$571,191	($549,000)	$69,796
Exhaust/Supply Energy Recovery 2025	($808,762)	($257,482)	($1,066,244)	$341,689	($824,555)	($593)
Domestic Hot Water Partial Electrification (80%) 2027	$0	($923,509)	($923,509)	$329,794	($593,715)	($31,699)
Total Budget	($1,658,448)	($1,451,501)	($3,109,949)	$1,242,674	($1,867,275)	$37,504

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The Victory - Tenant Projects

Projects to be completed at time of tenant roll-over and longer-term implementation

Replace Showerheads with Low GPM Fixture	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Total Capital Costs	($24,096)	($25,315)	($26,596)	($27,941)								
Base Costs	$0	$0	$0	$0								
Incremental Costs (Total - Base)	($24,096)	($25,315)	($26,596)	($27,941)								
Incentives	$8,948	$8,948	$8,948	$8,948								
Landlord Energy Cost Savings		$4,236	$8,930	$13,969	$19,561	$20,542	$21,571	$22,659	$23,798	$25,014	$26,298	$27,649

Energy Efficient Appliances	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Total Capital Costs	$139,208	$146,252	$153,652	$161,427	$169,595	$178,177	$187,193	$196,665	$206,616	$217,071	$228,054	
Base Costs	($139,208)	($146,252)	($153,652)	($161,427)	($169,595)	($178,177)	($187,193)	($196,665)	($206,616)	($217,071)	($228,054)	
Incremental Costs (Total - Base)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
Incentives	$6,648	$6,648	$6,648	$6,648	$6,648	$6,648	$6,648	$6,648	$6,648	$6,648	$6,648	$6,648
Tenant Energy Cost Savings		$4,444	$9,532	$14,998	$20,960	$27,465	$34,546	$42,271	$50,645	$59,823	$69,805	$80,650

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The Victory - Tenant Projects

Projects to be completed at time of tenant roll-over and longer-term implementation

Replace PTAC with PTHP	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Total Capital Costs	($424,098)	($445,558)	($468,103)	($491,789)	($516,673)	($542,817)	($570,284)	($599,140)	($629,456)	($661,307)	($694,769)	
Base Costs	($85,877)	($90,222)	($94,787)	($99,583)	($104,622)	($109,916)	($115,478)	($121,321)	($127,460)	($133,909)	($140,685)	
Incremental Costs (Total - Base)	($338,222)	($355,336)	($373,316)	($392,206)	($412,051)	($432,901)	($454,806)	($477,819)	($501,996)	($527,397)	($554,084)	
Incentives	$150,492	$150,492	$150,492	$150,492	$150,492	$150,492	$150,492	$150,492	$150,492	$150,492	$150,492	
Landlord Energy Cost Savings		$13,329	$27,430	$42,557	$59,766	$78,655	$99,374	$122,051	$146,878	$173,930	$203,503	$235,678
Tenant Energy Cost Savings		($28,105)	($60,169)	($94,609)	($132,248)	($173,327)	($218,059)	($266,865)	($319,798)	($377,797)	($440,888)	($509,439)

Replace proposed Condensing Dryers with heat pump Washer/Dryer	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Total Capital Costs	($57,872)	($60,801)	($63,877)	($67,109)	($70,505)	($74,073)						
Base Costs	($51,886)	($54,512)	($57,270)	($60,168)	($63,212)	($66,411)						
Incremental Costs (Total - Base)	($5,986)	($6,289)	($6,607)	($6,942)	($7,293)	($7,662)						
Incentives	$8,815	$8,815	$8,815	$8,815	$8,815	$8,815						
Tenant Energy Cost Savings		$6,293	$13,473	$21,185	$29,614	$38,812	$48,829	$51,221	$53,708	$56,398	$59,235	$62,223

EMPIRE STATE REALTY TRUST

The Chesapeake – Future Projects (2-3 years, 2025-2027)

Project	Base Cost ($)	Incremental Cost ($)	Total Cost ($)	Anticipated Incentives ($)	Total Cost w/ Incentives ($)	Annual Landlord Energy Cost Savings ($)
Exhaust/Supply Energy Recovery 2025	($339,557)	($193,316)	($532,873)	$183,155	($349,718)	$22,019
Domestic Hot Water Partial Electrification (67%) 2027	$0	($661,952)	($661,952)	$138,503	($523,449)	$23,683
Total Budget	**($339,557)**	**($855,268)**	**($1,194,825)**	**$321,658**	**($873,167)**	**$45,702**

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The Chesapeake - Tenant Projects

Projects to be completed at time of tenant roll-over and longer-term implementation

Replace proposed Condensing Dryers with heat pump dryers	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Total Capital Costs	($15,942)	($16,749)	($17,596)	($18,486)	($19,422)	($20,405)						
Base Costs	($11,782)	($12,378)	($13,004)	($13,662)	($14,353)	($15,080)						
Incremental Costs (Total - Base)	($4,160)	($4,371)	($4,592)	($4,824)	($5,069)	($5,325)						
Incentives	$2,578	$2,578	$2,578	$2,578	$2,578	$2,578						
Energy Cost Savings	$0	$1,837	$3,933	$6,184	$8,644	$11,329	$14,252	$14,950	$15,676	$16,462	$17,290	$18,162

Replace Showerheads With Low Flow GPM & Provide Aerators to Faucets.	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Total Capital Costs	($15,497)	($16,282)	($17,105)	($17,971)								
Base Costs	$0	$0	$0	$0								
Incremental Costs (Total - Base)	($15,497)	($16,282)	($17,105)	($17,971)								
Incentives	$3,652	$3,652	$3,652	$3,652								
Landlord Energy Cost Savings	$0	$2,431	$5,114	$7,995	$11,198	$11,762	$12,354	$12,979	$13,634	$14,332	$15,070	$15,846

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The Chesapeake - Tenant Projects

Projects to be completed at time of tenant roll-over and longer term implementation

Replace PTAC with PTHP	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Total Capital Costs	($253,976)	($266,827)	($280,328)	($294,513)	($309,416)	($325,072)	($341,521)	($358,801)	($376,957)	($396,031)	($416,070)	
Base Costs	($43,540)	($45,743)	($48,058)	($50,490)	($53,045)	($55,729)	($58,549)	($61,511)	($64,624)	($67,894)	($71,329)	
Incremental Costs (Total - Base)	($210,436)	($221,084)	($232,270)	($244,023)	($256,371)	($269,343)	($282,972)	($297,290)	($312,333)	($328,137)	($344,741)	
Incentives	$62,459	$62,459	$62,459	$62,459	$62,459	$62,459	$62,459	$62,459	$62,459	$62,459	$62,459	
Tenant Energy Cost Savings	$0	($16,616)	($35,573)	($55,934)	($78,187)	($102,473)	($128,919)	($157,773)	($189,068)	($223,358)	($260,658)	($301,186)
Landlord Energy Cost Savings	$0	$12,690	$26,115	$40,516	$56,900	$74,883	$94,609	$116,199	$139,835	$165,590	$193,744	$224,377

EMPIRE STATE REALTY TRUST

Number of Market Unregulated, Stabilized and Affordable units per Building

	Total Units	Market Unregulated[2]	Market Stabilized[3]	Affordable Stabilized[3]	Tax Abatement/ Regulation End Year	Will Market Stabilized be continued if abatement is renewed?
298 Mulberry	96	96	-	-	-	No plans to change to affordable units
The Victory	417	-	317	100 (32%)	2025	If tax abatement is extended beyond 2025, market stabilized units will change to market unregulated and additional affordable units would be required
Chesapeake	208	154	-	54 LIHTC[1] (35%)	In perpetuity	Recently renewed tax abatement in perpetuity

Notes
1. LIHTC: Low-Income Housing Tax Credit Program
2. Market unregulated assumes lease term updates are permitted at lease renewal
3. Market stabilized and affordable stabilized assumes DHCR approval would requested and granted for lease term updates at lease roll-over

Domestic Hot Water Electrification

DHW Electrification, % of total domestic hot water supplied per ECM

	EL06 Partial Electrification - Equipment Utilization Optimized[1]	**EL02** Near Full Electrification - Equipment Infrastructure Optimized[2]	**EL05** Full Electrification[3]	Recommended Package and ECM
Mulberry	80% - Mid & High	93% - Max	100% - N/A	Mid – EL06
Victory	80% - Mid	95% - High	100% - Max	Mid – EL06
Chesapeake	67% - Mid	95% - High	100% - Max	Mid – EL06

Notes:
1. Partial Electrification - Equipment Utilization Optimized: heat pump and system sized to maximize utilization rate of newly installed equipment
2. Near Full Electrification - Equipment Infrastructure Optimized: heat pump sized to maximize proportion of DHW load covered by new system without requiring new building electric service
3. Full Electrification: heat pump sized to cover 100% of domestic hot water requirements. ECM pricing includes N+1 redundancy at most operating temperatures, but fossil fuel systems may be retained to help cover unplanned equipment outages during severe weather.

Financial Model Assumptions Used for Discounted Cashflow Analysis

- Real discount rate: 6%
- Construction escalation rate: 3%
- Utility escalation rates used for analysis of buildings in 2022:

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Electricity	0.0%	0.0%	3.8%	0.1%	10.2%	27.9%	7.4%	7.0%	4.8%	4.8%	4.8%	4.8%	4.9%	4.9%	5.0%	5.0%	5.0%
Natural Gas	0.0%	0.0%	1.4%	2.8%	42.5%	-9.7%	0.4%	2.9%	3.4%	5.3%	5.3%	5.3%	5.3%	5.3%	5.3%	5.3%	5.3%

- Previous utility escalation rates used for analysis of buildings in 2021:

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Electricity	0.0%	0.0%	3.8%	5.2%	3.7%	9.4%	5.1%	5.1%	5.0%	5.0%	5.0%	5.0%	4.6%	4.6%	4.8%	4.8%	4.9%
Natural Gas	0.0%	0.0%	0.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%

Utility Rates Based on Discounted Cashflow Analysis

Utility rates used for analysis of buildings in 2022

298 Mulberry

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Electricity ($/kWh)	$0.17	$0.17	$0.17	$0.17	$0.19	$0.24	$0.26	$0.27	$0.29	$0.30	$0.32	$0.33	$0.35	$0.36	$0.38	$0.40	$0.42
Natural Gas ($/therm)	$1.20	$1.20	$1.22	$1.25	$1.78	$1.61	$1.62	$1.66	$1.72	$1.81	$1.91	$2.01	$2.11	$2.23	$2.34	$2.47	$2.60

561 10th Avenue “The Victory

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Electricity ($/kWh)	$0.17	$0.17	$0.17	$0.17	$0.19	$0.24	$0.26	$0.27	$0.29	$0.30	$0.32	$0.33	$0.35	$0.36	$0.38	$0.40	$0.42
Natural Gas ($/therm)	$1.20	$1.20	$1.22	$1.25	$1.78	$1.61	$1.62	$1.66	$1.72	$1.81	$1.91	$2.01	$2.11	$2.23	$2.34	$2.47	$2.60

Utility Rates Based on Discounted Cashflow Analysis

Utility rates used for analysis of buildings in 2022

345 E94th St. “The Chesapeake”

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Electricity ($/kWh)	$0.17	$0.17	$0.17	$0.17	$0.19	$0.24	$0.26	$0.27	$0.29	$0.30	$0.32	$0.33	$0.35	$0.36	$0.38	$0.40	$0.42
Natural Gas ($/therm)	$1.20	$1.20	$1.22	$1.25	$1.78	$1.61	$1.62	$1.66	$1.72	$1.81	$1.91	$2.01	$2.11	$2.23	$2.34	$2.47	$2.60

Simple Payback Calculation Description

- Simple payback is calculated using:
  - Incremental capital cost associated with complete implementation of the ECM or package, based on 2023 cost estimates
  - Incentives available for complete implementation of the ECM or package, calculated using latest rates for programs from Con Edison and NYSERDA
  - Energy cost savings associated with complete implementation of the ECM or package, calculated using 2023 utility rates
  - Estimated annual impact to maintenance and repairs of systems

$$\text{Simple Payback} = \frac{\text{Incremental Capital Cost} - \text{Incentives}}{\text{Annual Energy Cost Savings} + \text{Annual Maintenance Impacts}}$$