BUILDINGENERGY BOSTON

Pushing the Glass Envelope: A BERDO 2.0 Compliance Pathway for a High Performance Building

Samira Ahmadi (enviENERGY Studio)
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Curated by Shari Rauls and Tammy Ngo

Northeast Sustainable Energy Association (NESEA)
March 29, 2023

Learning Objectives

1. Recognize how to create opportunities for creating an innovative building design from aggressive performance goals.
2. Organize an integrative design process that engages owners and tenants in a collaborative and iterative process of optimizing high performance solutions.
3. Evaluate predictive energy models, actual data, and assess future opportunities to improve performance and meet future code requirements.
4. Understand challenges facing recently opened new buildings that will need to decarbonize in the near future.

Presenters

Peter Zmuidzinas

AIA, LEED AP

Vice President

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BEMP, LEED AP, WELL AP

Founding Principal

enviENERGY Studio

Sean Anderson

Head of Corp Real Estate

MassMutual Financial Group

MassMutual

SUSTAINABILITY AND MUTUALITY

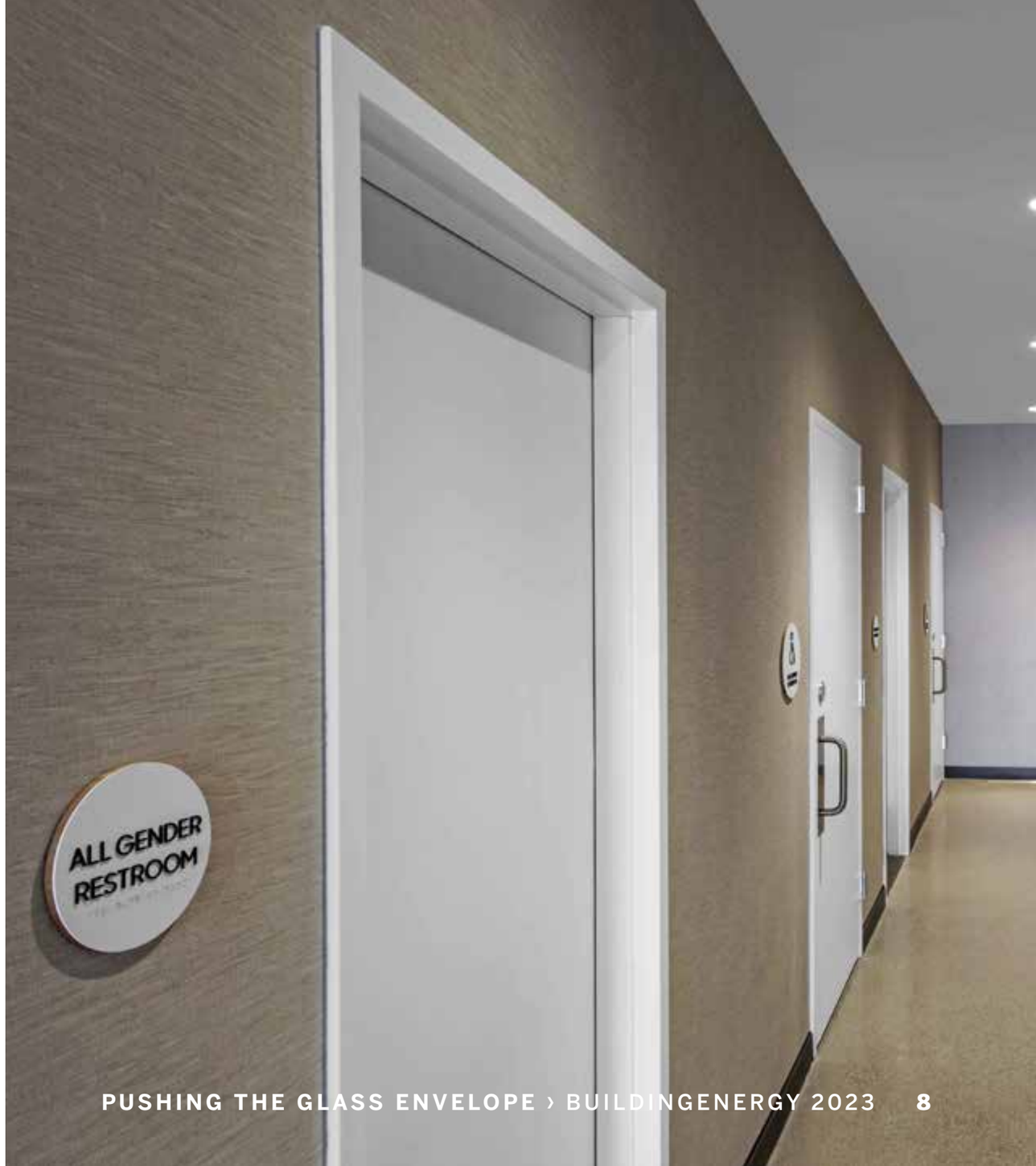
- **Mutually held** since founding in 1851
- MassMutual's guiding principle is the notion of **living mutual** — that the world is better when we look out for one another
- **Environmental stewardship** is a critical strategic priority
- MassMutual is committed to creating a **diverse, equitable, and inclusive workplace**

10 Fan Pier

- **Location**, Location, Location....
- Equitable and **healthy environment** for employees
- Energy efficiency and **stewardship**

10 Fan Pier

- 1.35 acres in the Seaport
- 17 Stories
- 345,000 GSF Office
- Biophilic design
- LEEDv4 CS Platinum


ALL GENDER
RESTROOM

LEED v4 CS Platinum

RESILIENCY

RAINWATER HARVESTING

HEALTHY INTERIOR AIR QUALITY

BIOPHILIC DESIGN

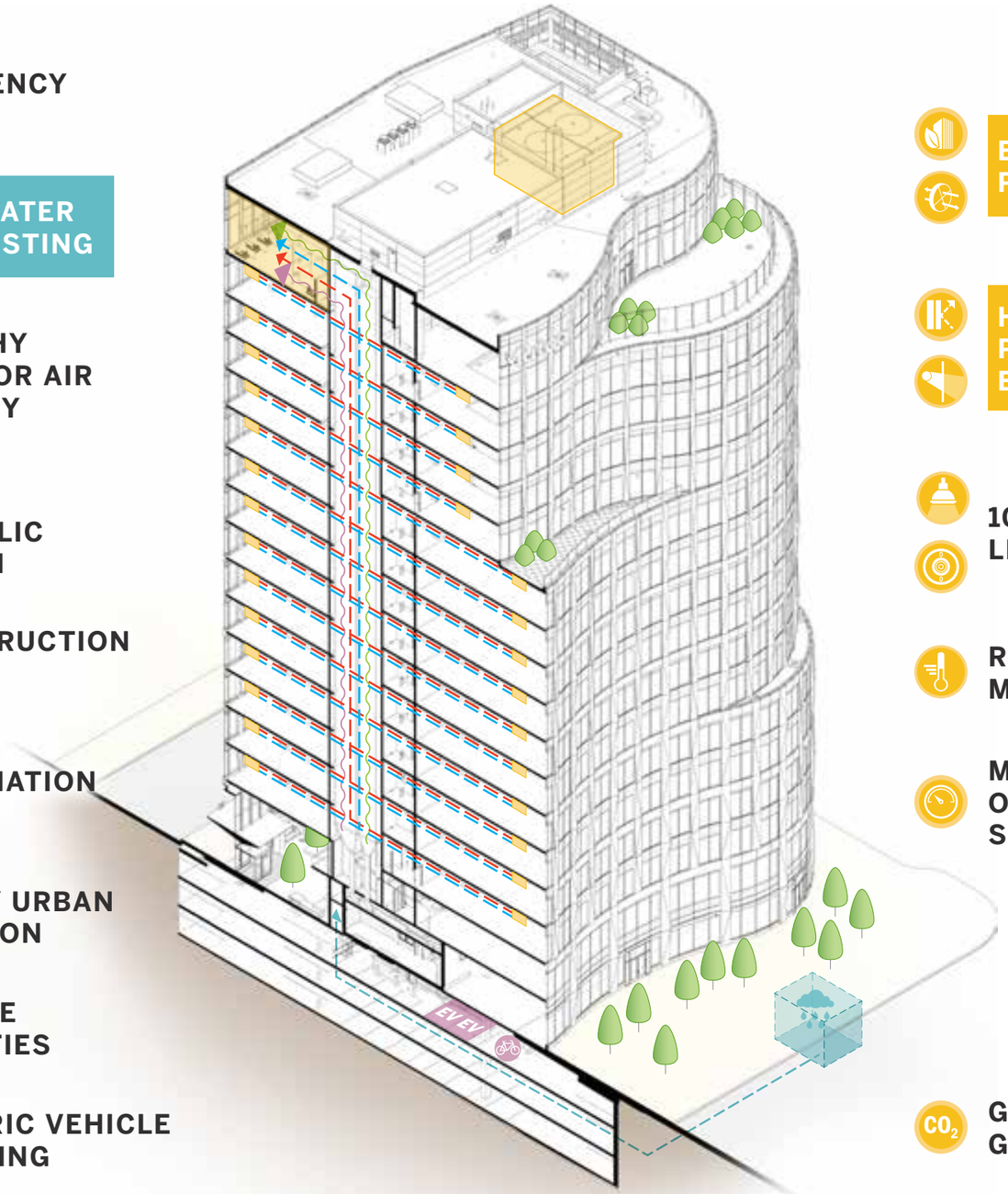
CONSTRUCTION WASTE

SOIL REMEDIATION

HIGHLY URBAN LOCATION

BICYCLE FACILITIES

ELECTRIC VEHICLE CHARGING



ENERGY PERFORMANCE

HIGH PERFORMANCE ENVELOPE

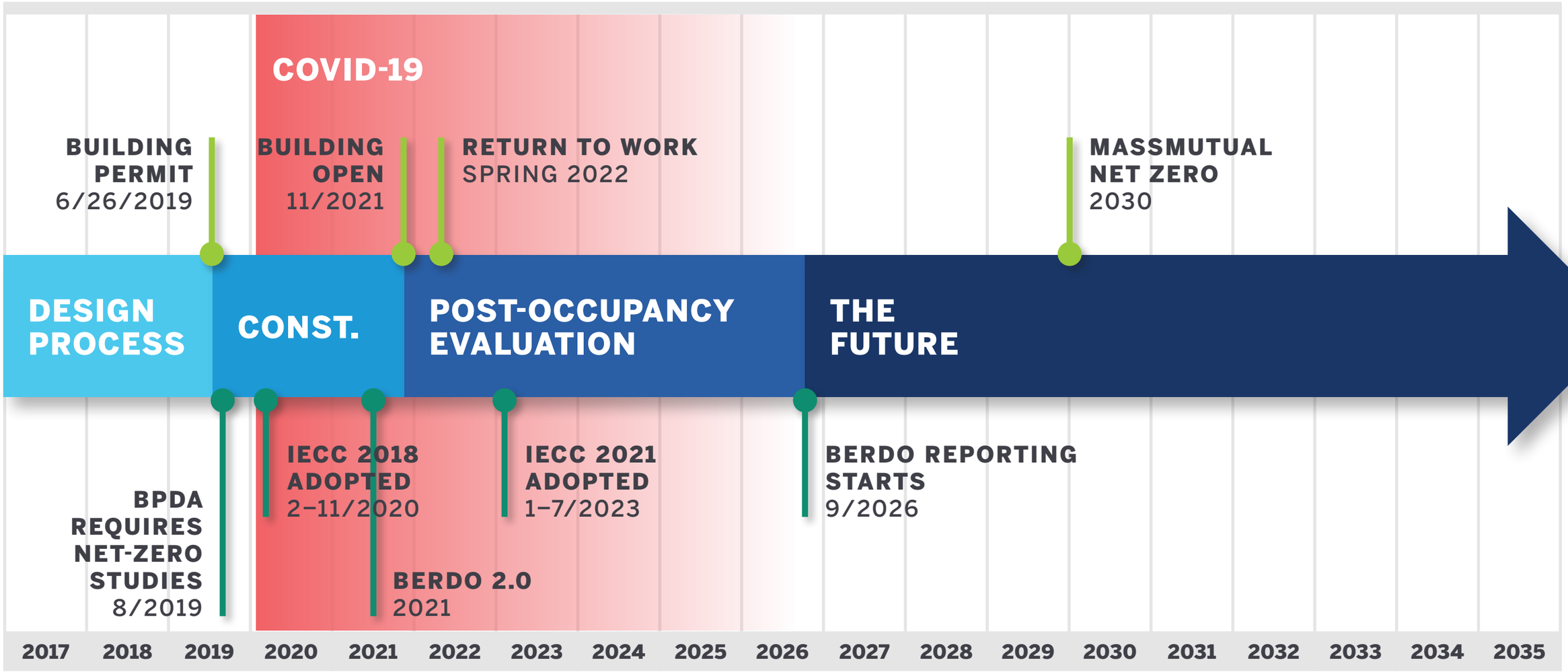
100% LED LIGHTING

REFRIGERATION MANAGEMENT

MONITORING OF MAJOR ENERGY SOURCES

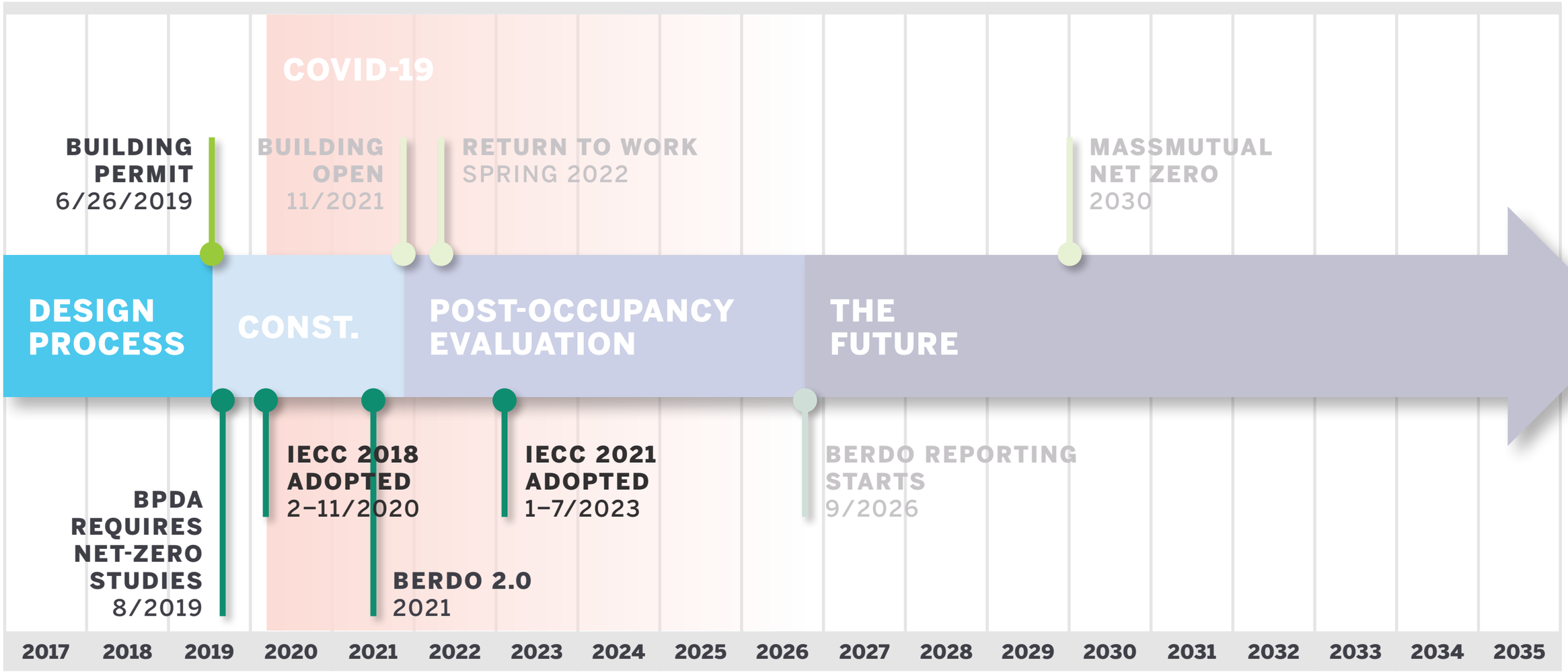
GREENHOUSE GAS

MassMutual Timeline



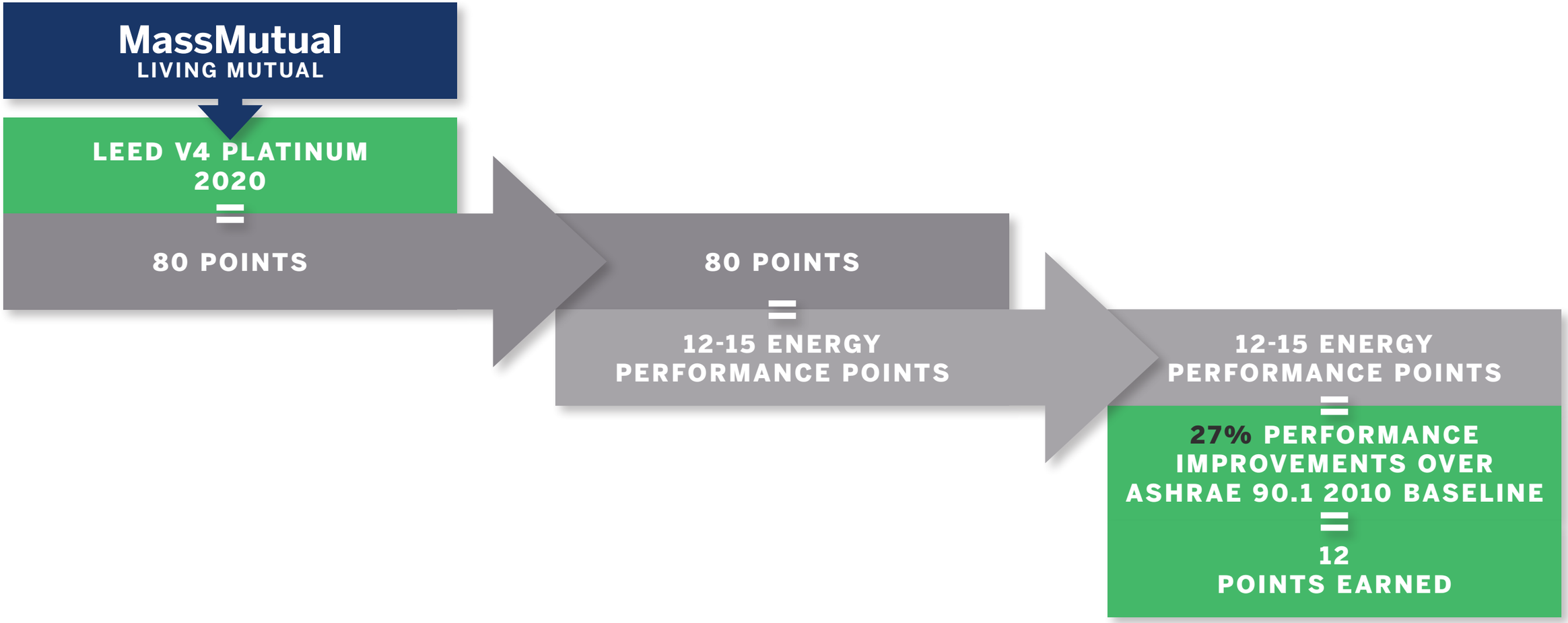
Design Process

TIMELINE



Design Process

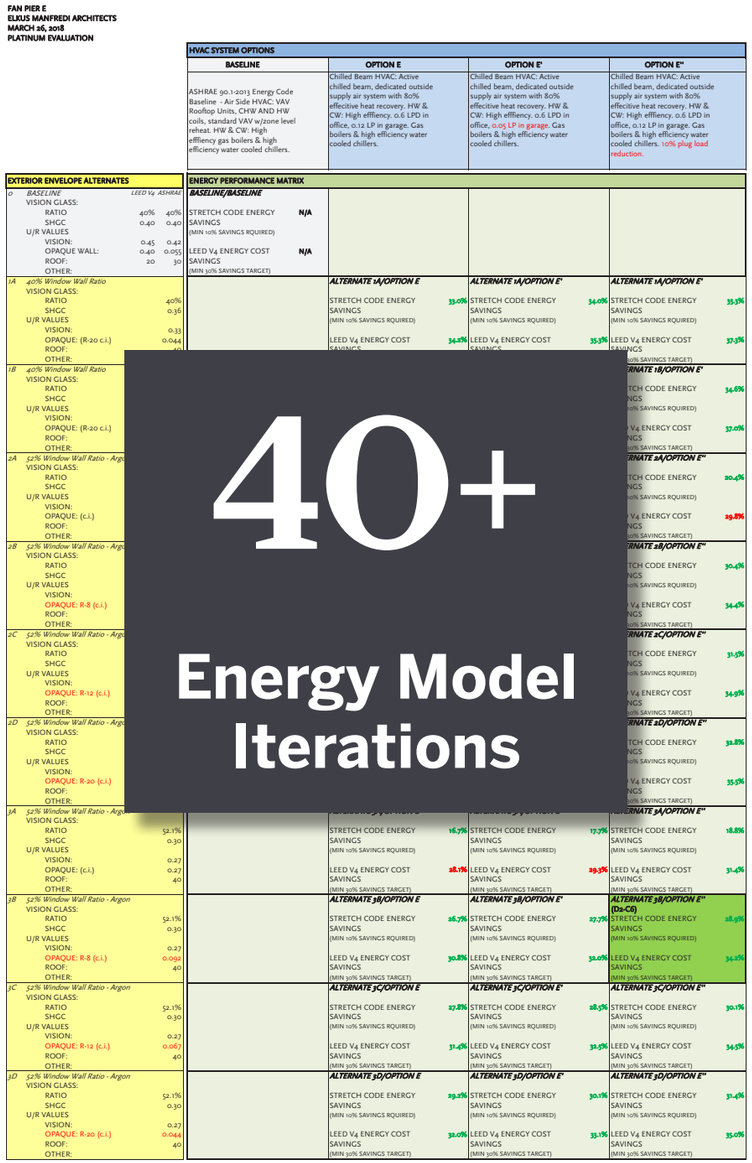
IDENTIFYING ENERGY PERFORMANCE GOALS



Design Process

ITERATIVE PROCESS

- Used LEEDv4 **Integrative Process Credit**
- Conceptual design in 2017: prior to **BPDA requiring net-zero studies**
- **Stretch Code:** 30% improvement over ASHRAE 90.1 2013 baseline
- Early **iterative** simple-box modeling to test a range of combinations
- **Market informed** set of considerations



Design Process

TARGET METRICS

12 pts

LEED v4

Energy cost savings target

30%

STRETCH ENERGY CODE

Annual energy use reduction target

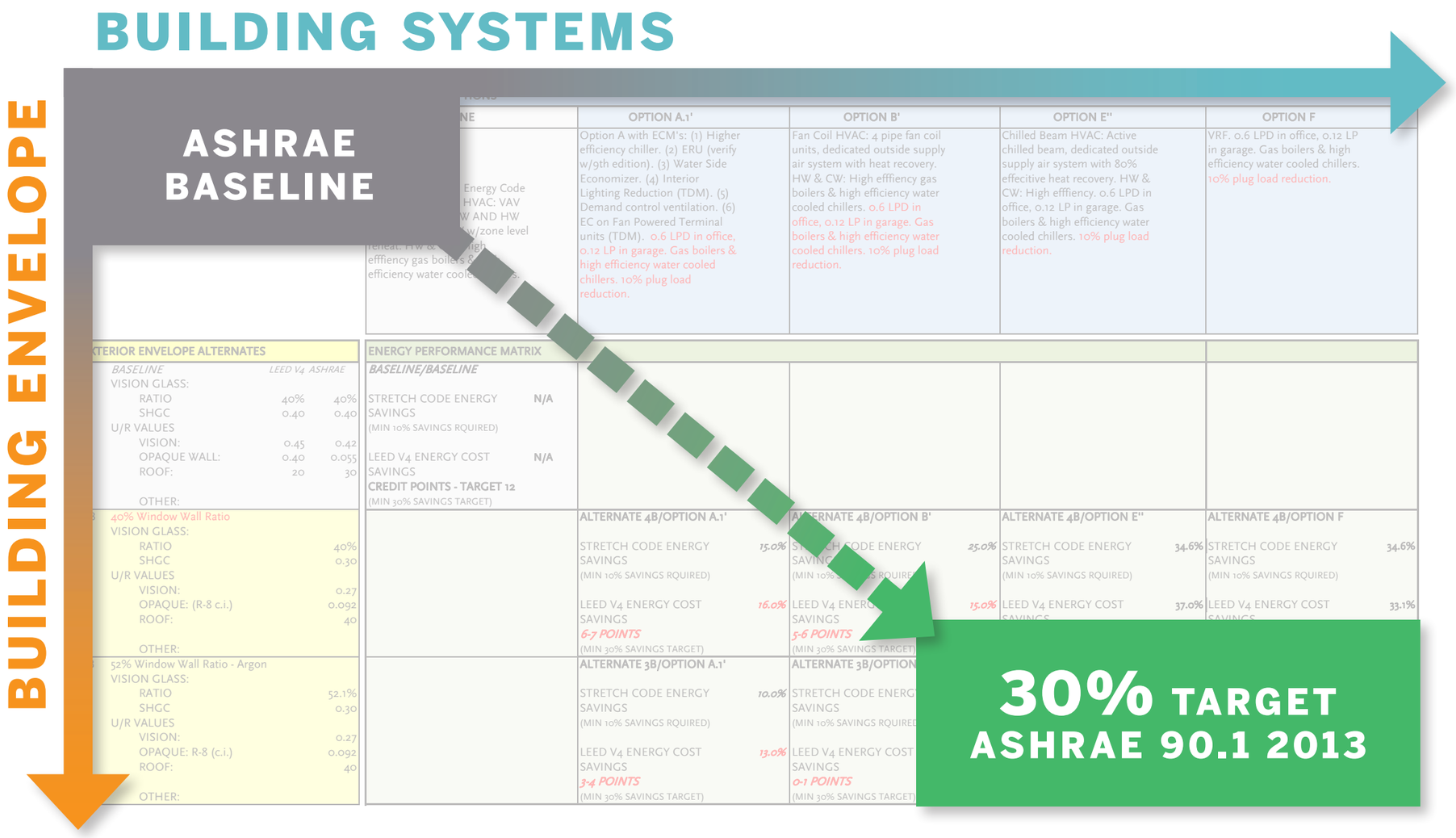
70%

AIA 2030

Target reduction over CBECS baseline for office buildings

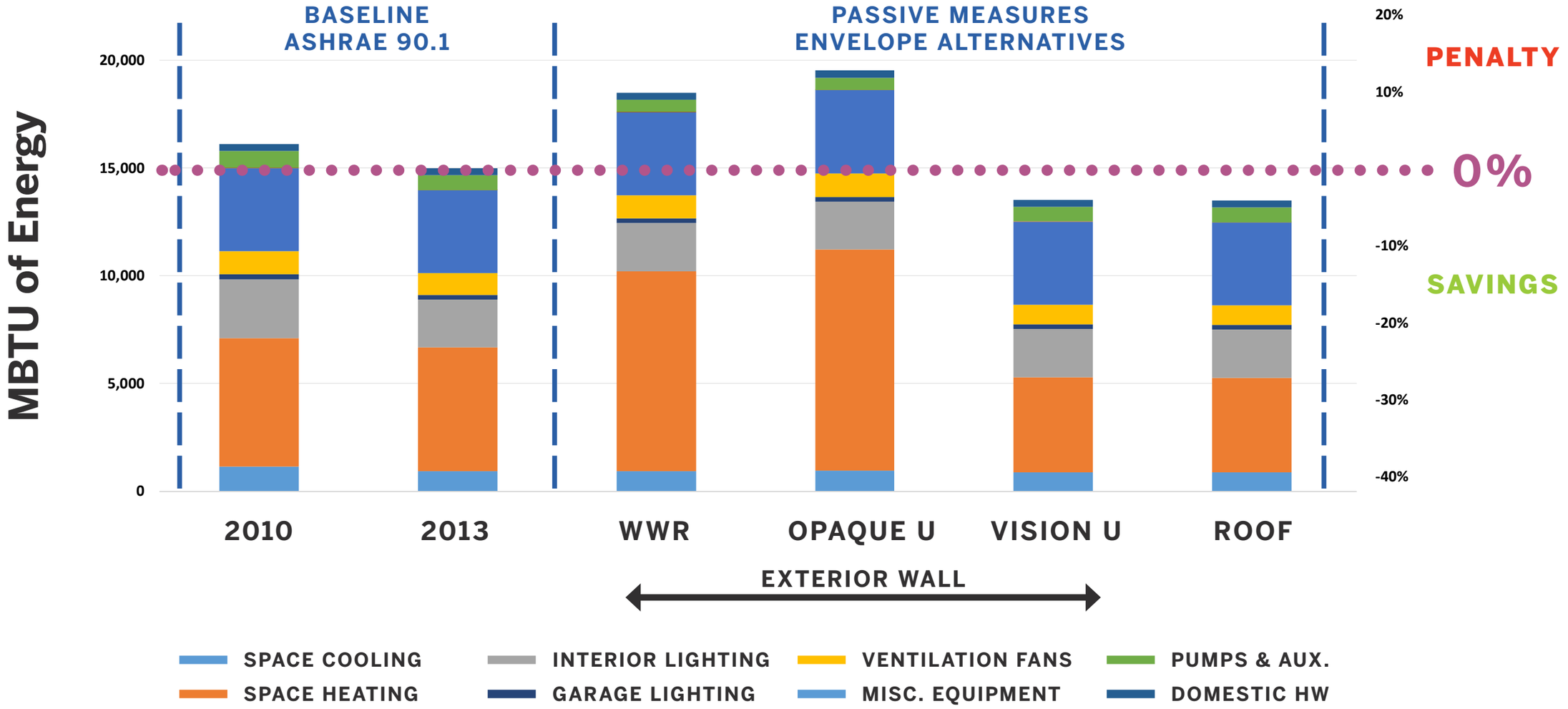
Design Process

MODELING MATRIX: ITERATIVE ALTERNATIVES



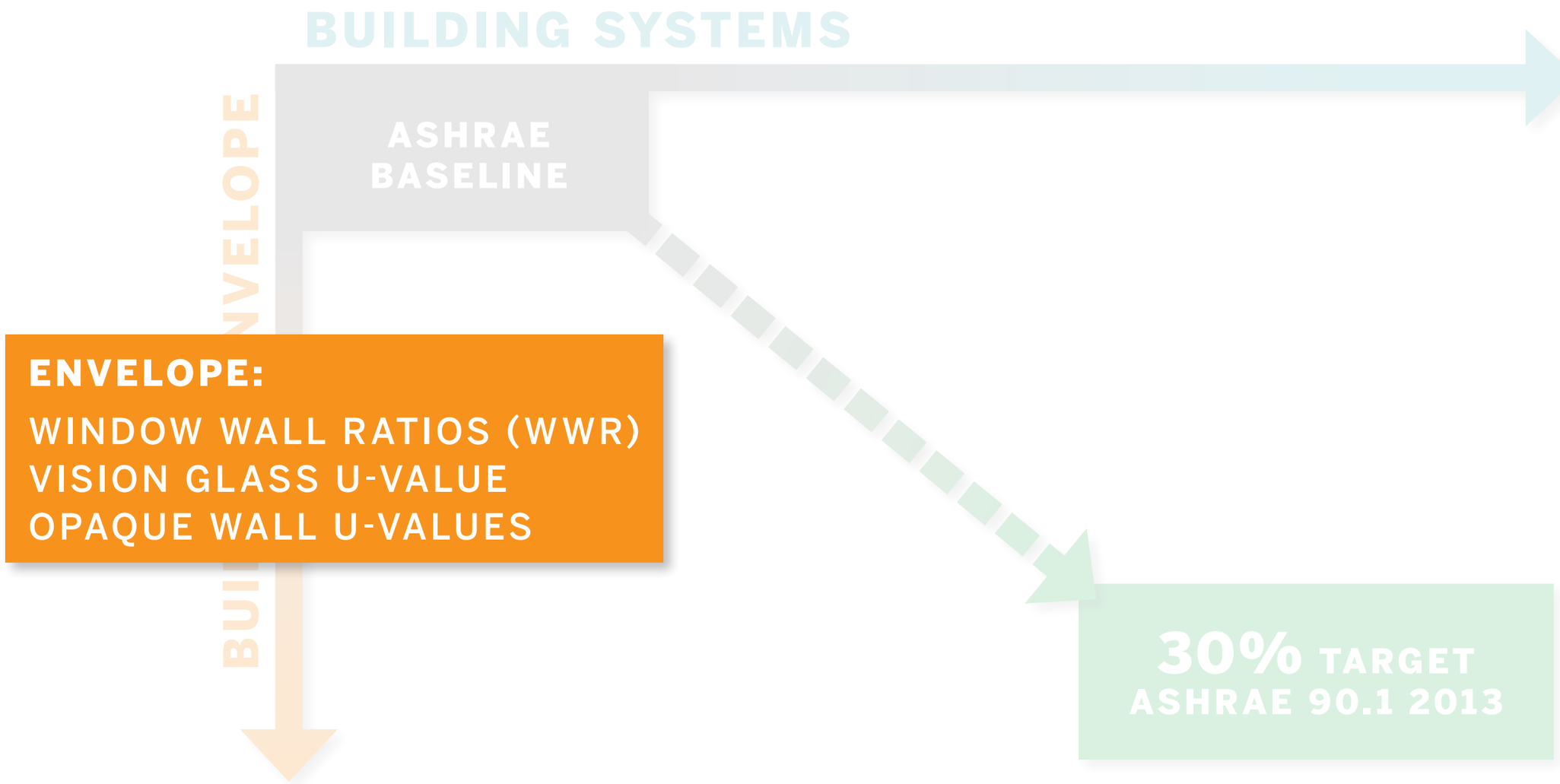
Design Process

BUILDING ENVELOPE: ENVELOPE TRADEOFF ANALYSIS



Design Process

BUILDING ENVELOPE: PERFORMANCE DRIVERS



Design Process

BUILDING ENVELOPE: PERFORMANCE ANALYSIS

- Building metrics
- Vision glass configurations
- Cladding materials
- I.G.U. assemblies
- Assembly U-values

ENVELOPE ALTERNATIVES ANALYSIS:

	BASELINE ASHRAE 90.1 2010/2013	MARKET BASIS CIRCA 2010–2018	ALTERNATIVES ANALYZED
WWR	40%	60+%	45%-65%
VISION GLASS	U = 0.45/0.42 SHGC = 0.40	U =~0.35 SHGC =~0.30~0.35	U= 0.20-0.40 SHGC = 0.13 - 0.140
OPAQUE WALL	U = 0.064/0.055 R-13 + C.I.	U = 0.15 - 0.20 (CURTAIN WALL)	U = 0.046-0.30 (CURTAIN WALL)

Design Process

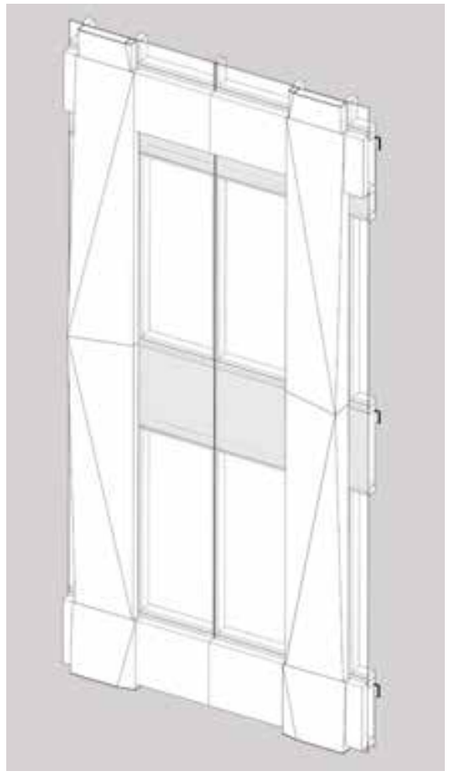
BUILDING ENVELOPE: DESIGN CONSIDERATIONS

- Performance
- Human comfort
- Aesthetics
- Cost
- Constructability










Design Process

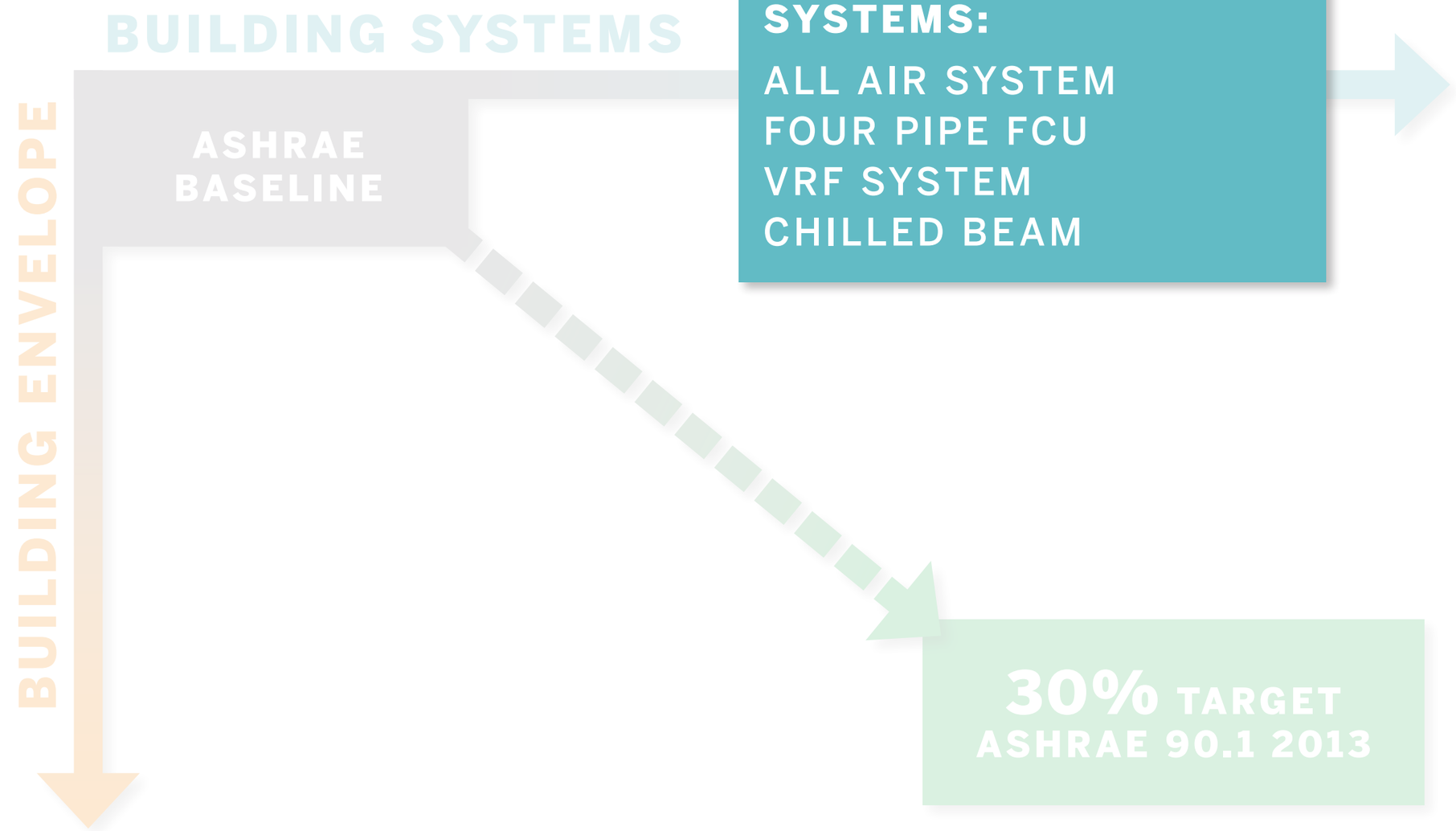
BUILDING ENVELOPE: DESIGN BASIS

	DESIGN BASIS
WWR	54%
VISION GLASS	U = 0.27 SHGC = 0.29
OPAQUE WALL	U = 0.092 (CURTAIN WALL)

- Reduced window wall ratio
- Room-side Low-E assembly
- Early adoption of enhanced envelope performance

Design Process

BUILDING SYSTEMS: PERFORMANCE ANALYSIS



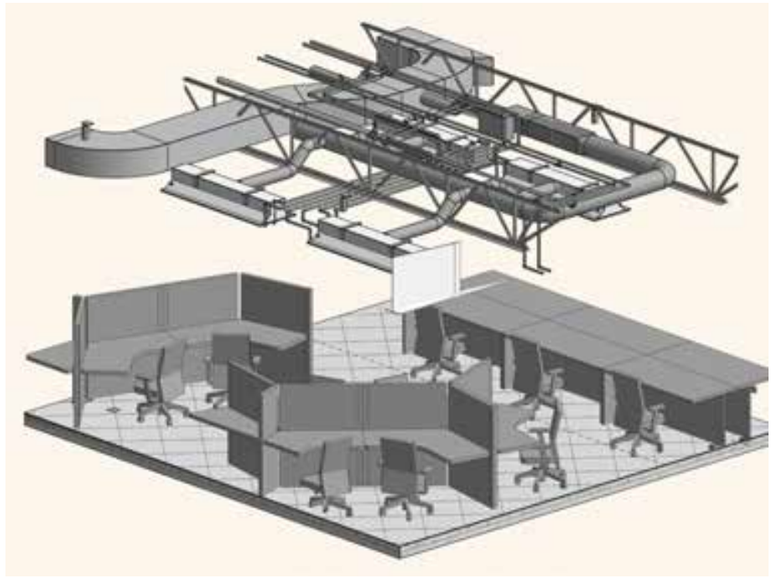
Design Process

SYSTEM ALTERNATIVES

Active Chilled Beam

› Fan energy savings

› Higher CHW temperature resulting in higher chiller efficiency (dedicated to ACBs)

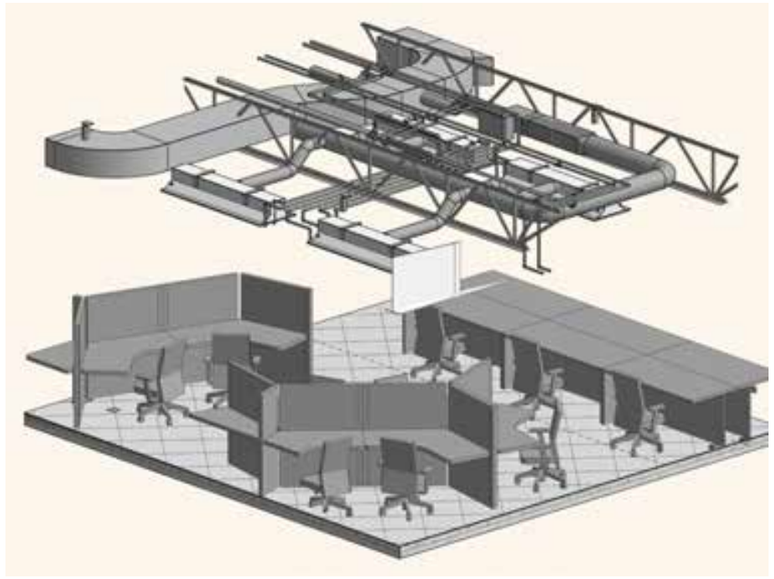


Design Process

SYSTEM ALTERNATIVES

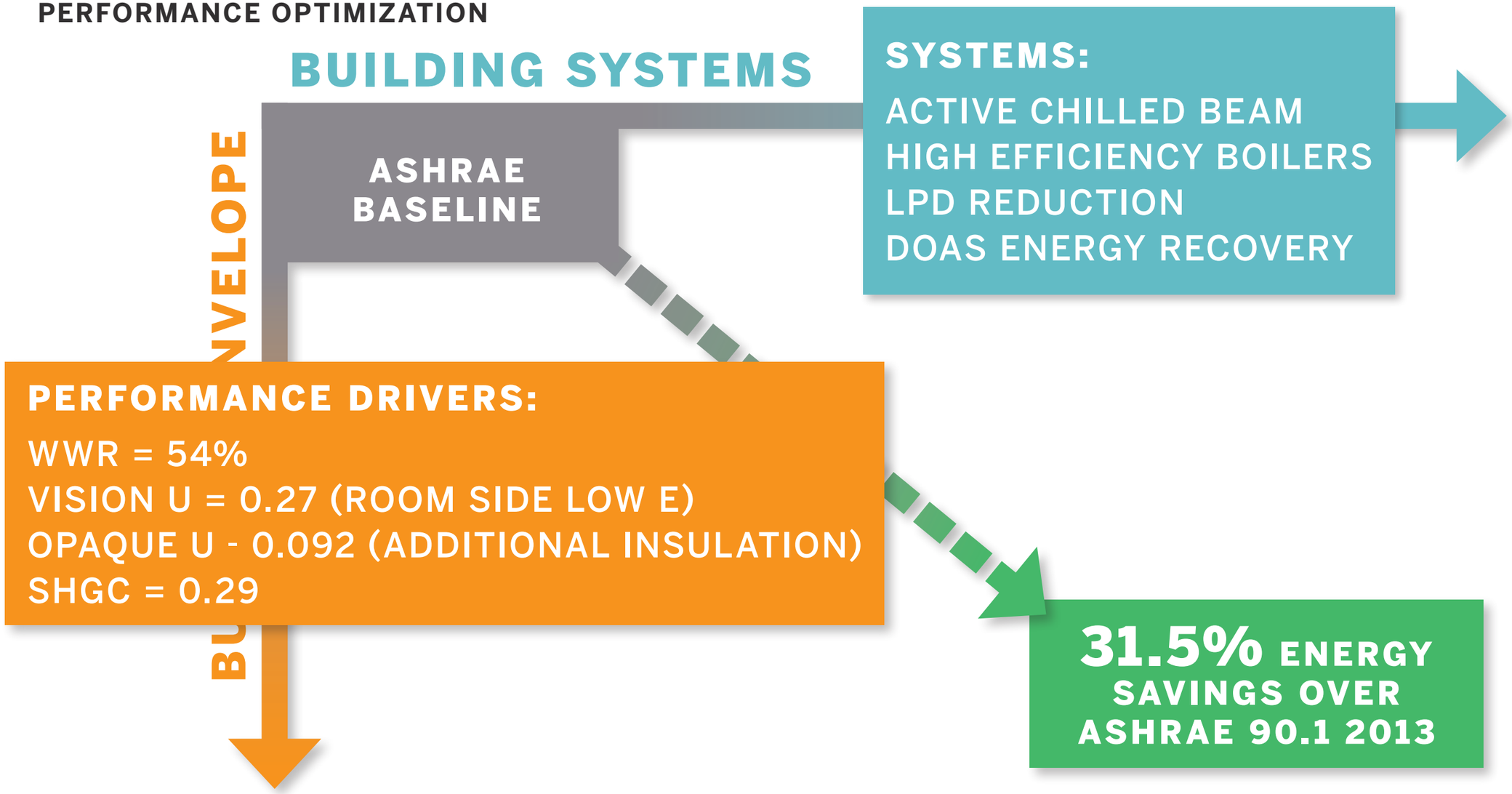
Architectural Considerations

- Cost tradeoffs - ductwork vs. piping
- Space allocation/ clear heights
- Lighting/MEP/FP coordination
- Acoustic performance



Design Process

PERFORMANCE OPTIMIZATION



Design Process

ACTUAL METRICS

12+1 pts

LEED v4

Actual EApc 95 GHG emission and source energy savings

31.5%

STRETCH ENERGY CODE

Actual annual energy use reduction

71%

AIA 2030

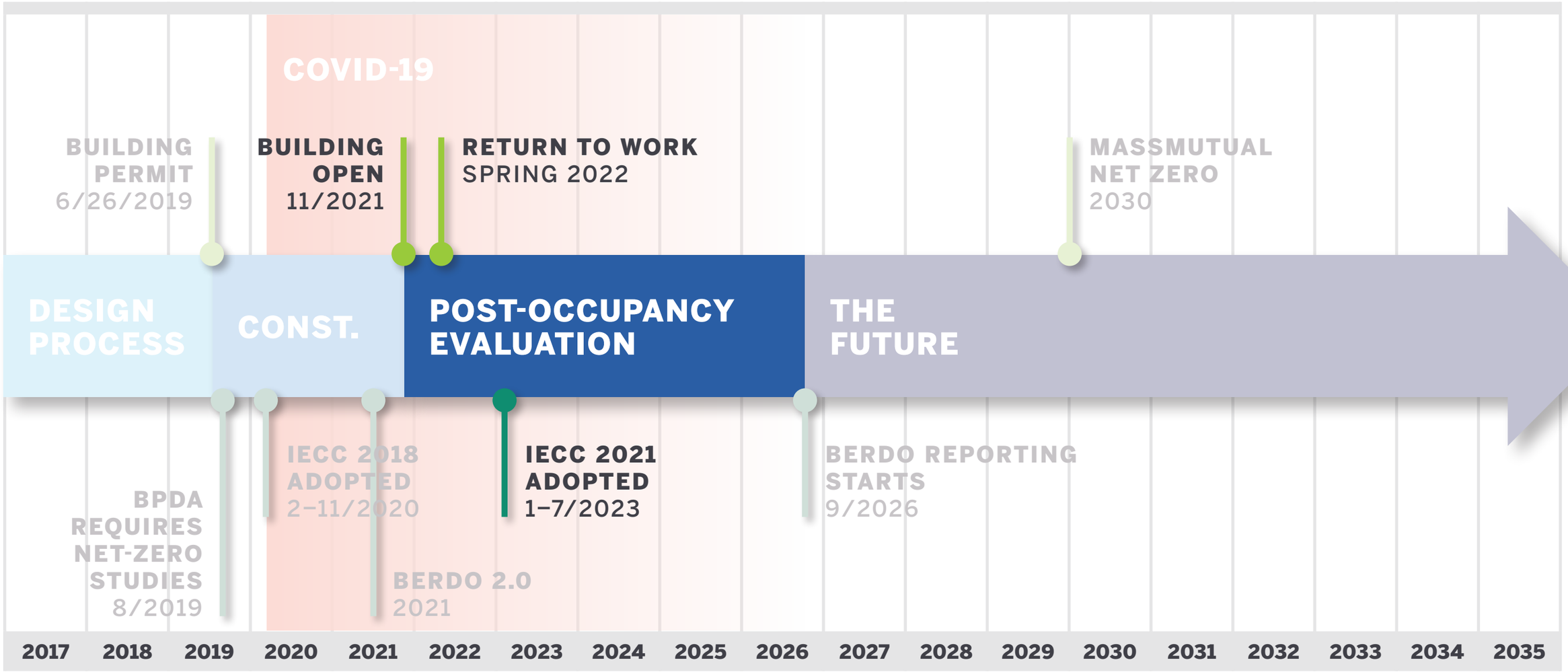
Actual reduction over CBECS baseline for office buildings

Design Process

FINDING THE BALANCE

Post-Occupancy Evaluation

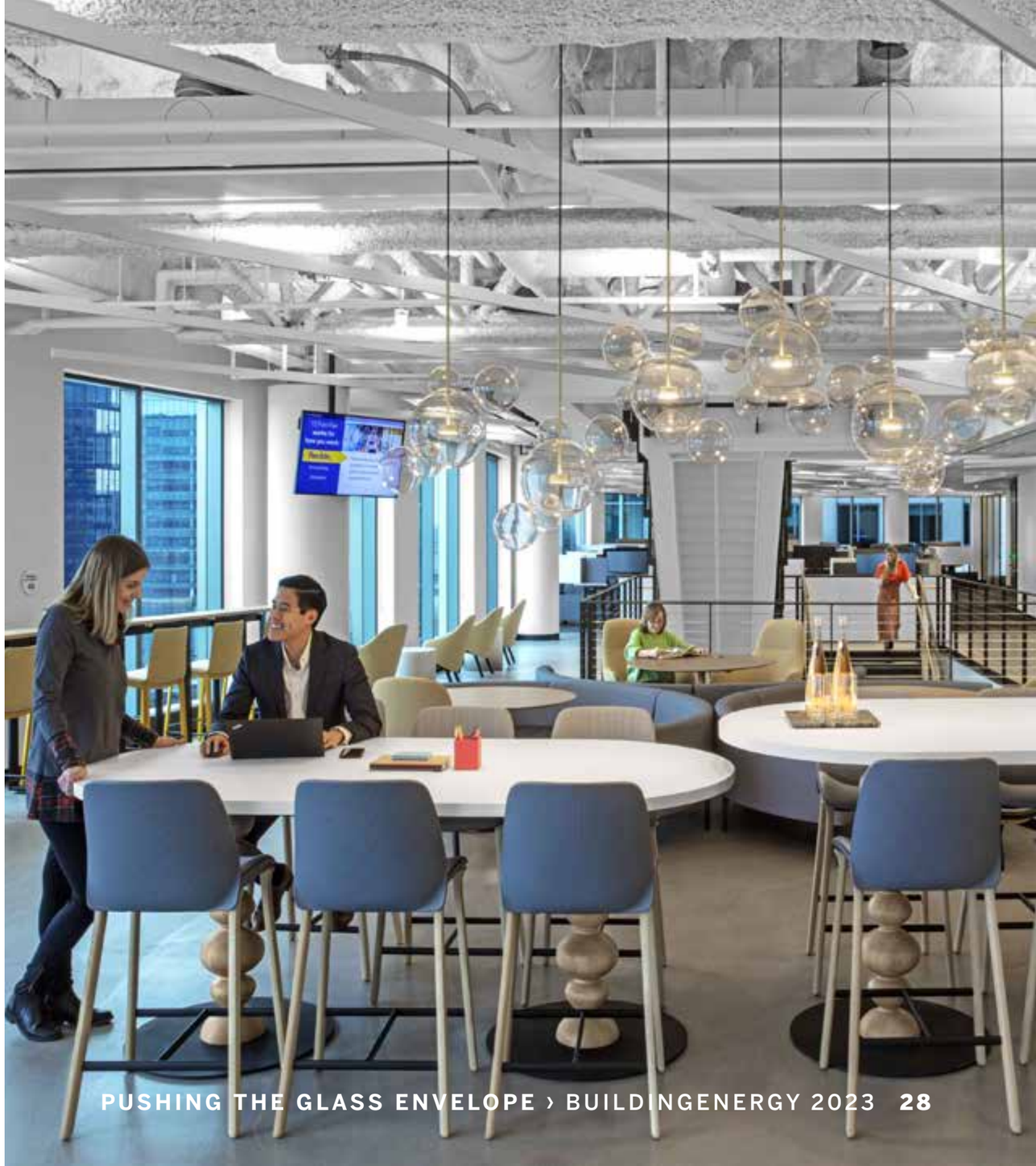
TIMELINE



Post-Occupancy Evaluation

MILESTONES

- COVID-19 start: March 2020
- Occupancy: November 2021
- Return to work: Spring 2022
- Commissioning
- Ongoing pandemic impact



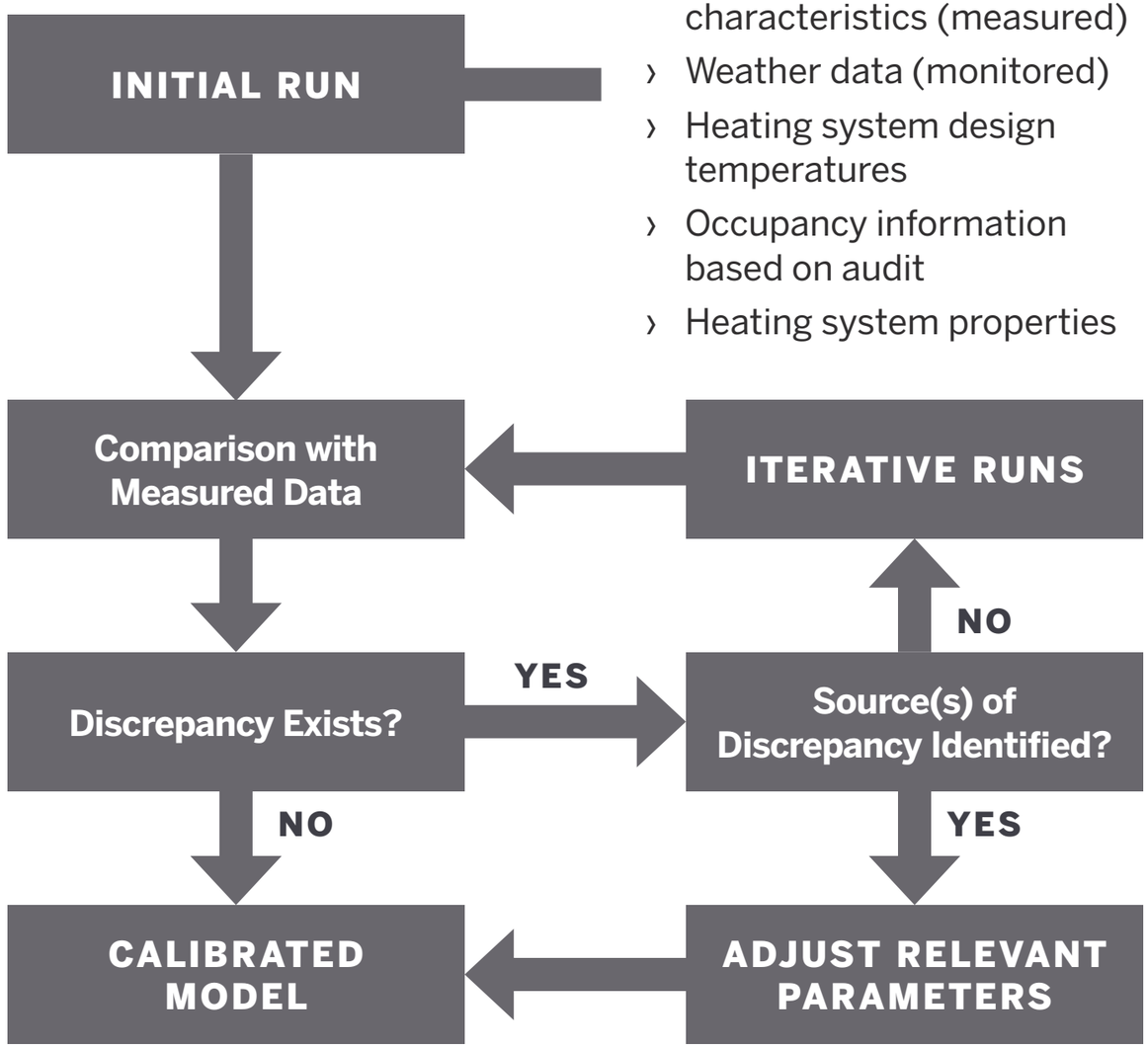
Post-Occupancy Evaluation

ENERGY MODEL CALIBRATION

- IPMVP and ASHRAE Guideline 14
- Gather **occupancy** and internal load schedules
- Compare the **weather** file to actual weather data
- A work in progress: **one year utility data is not sufficient** for model calibration

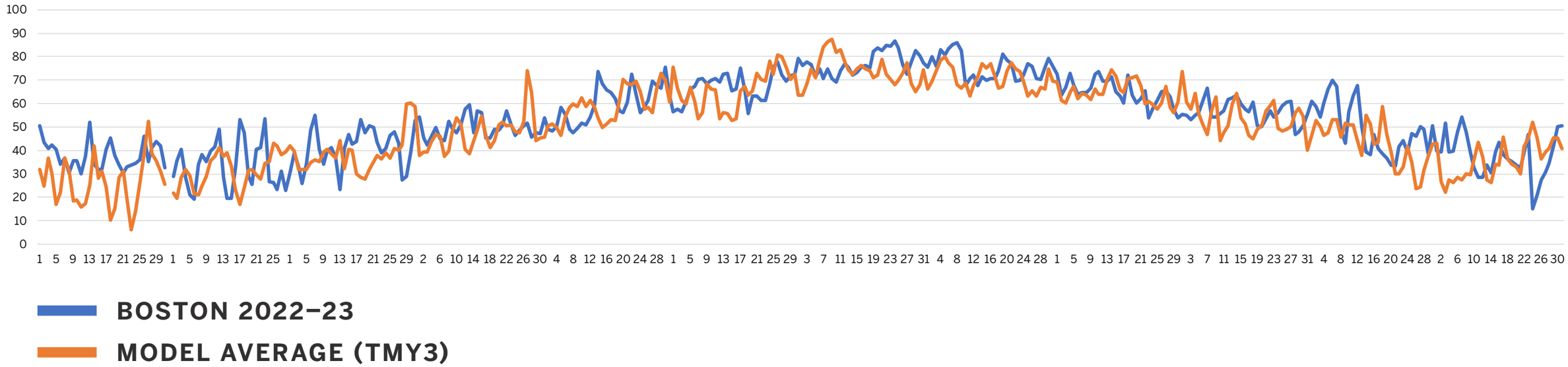
INCLUDES:

- As built information
- Building envelope characteristics (measured)
- Weather data (monitored)
- Heating system design temperatures
- Occupancy information based on audit
- Heating system properties



Boston Weather

ACTUAL VS MODELED



Post-Occupancy Evaluation

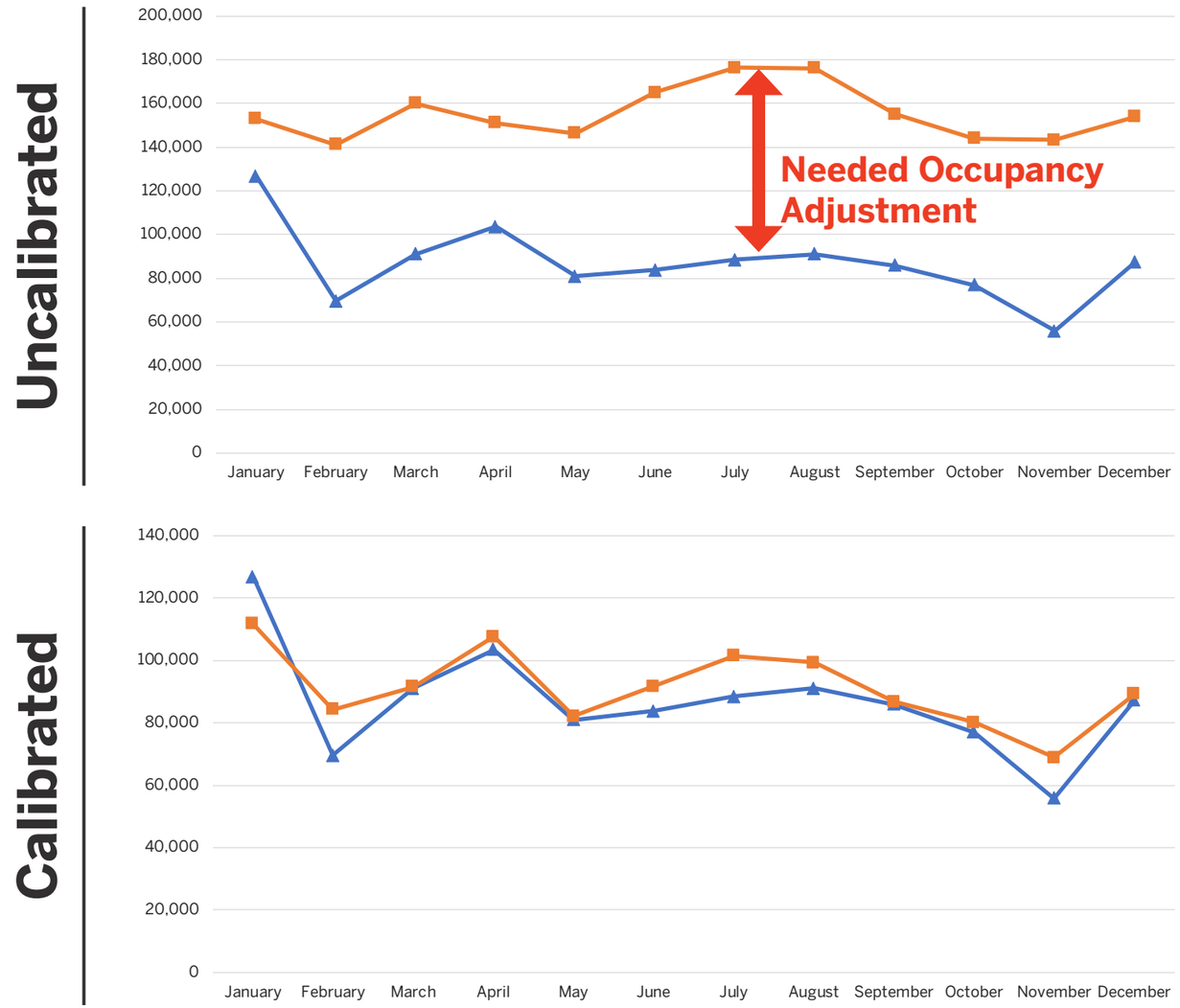
ELECTRIC CONSUMPTION

- Energy Model was developed and finalized pre-pandemic, assuming 90% occupancy throughout the week
- Per 2022 weekly schedule, the occupancy is at 30%
- Occupancy, lighting, and equipment densities were adjusted in the calibrated model to represent the actual schedules

ELECTRICITY (KWH) ACTUAL

ELECTRICITY (KWH) MODEL

MONTHLY ELECTRIC CONSUMPTION: ACTUAL VS MODELED

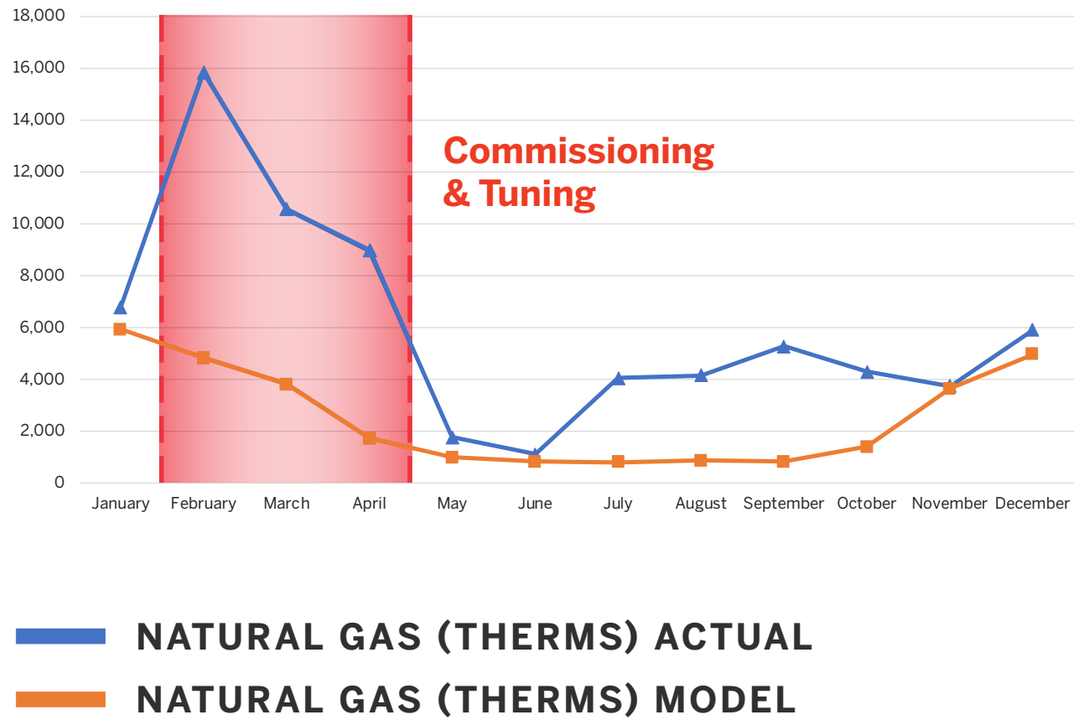


Post-Occupancy Evaluation

NATURAL GAS CONSUMPTION

- Predicted vs Actual
- Work in progress - one year utility data is not enough for model calibration
- Commissioning: February, March and April
- Monitoring-Based Commissioning in progress

MONTHLY GAS CONSUMPTION: ACTUAL VS MODELED



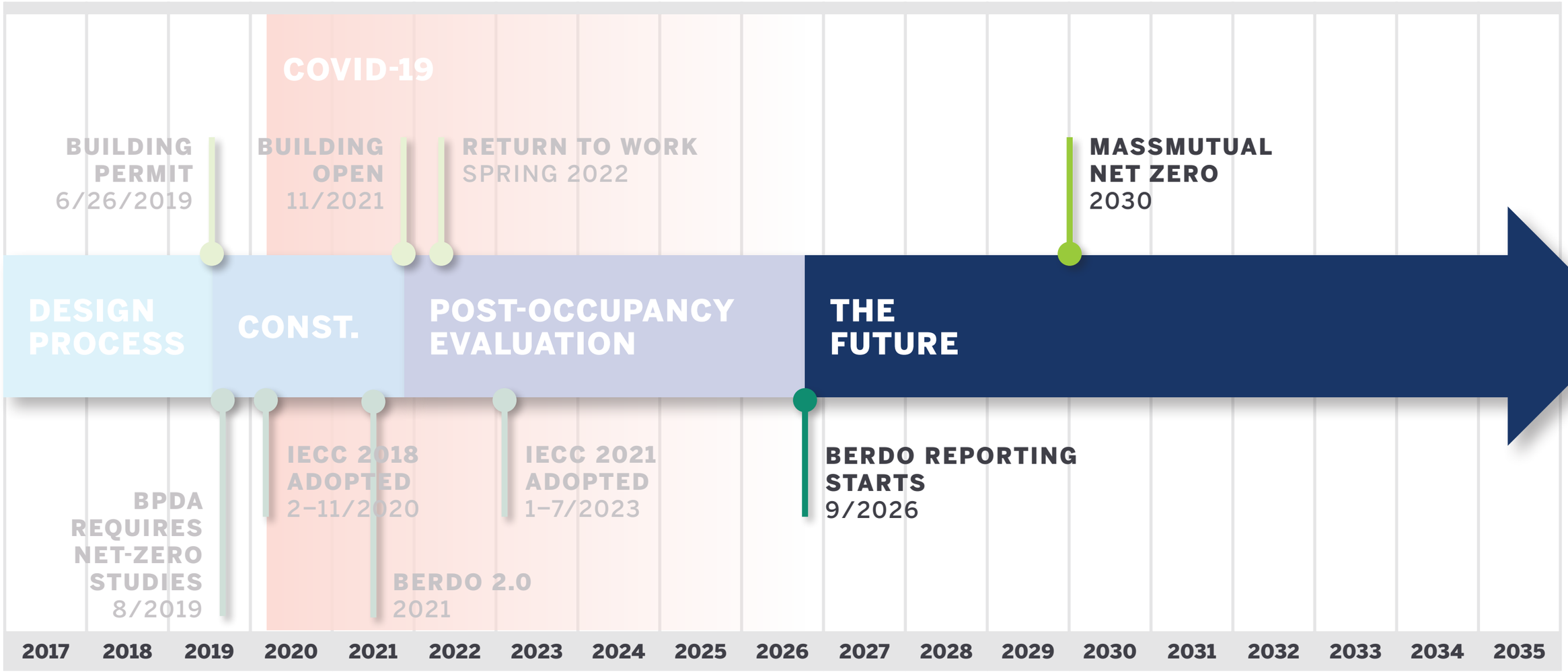
Post-Occupancy Evaluation

WHAT DID WE LEARN?

- **Employee experience** goals were met and exceeded
- **BMS lighting** controls required adjustment
- Lack of internal heat gain due to **unoccupied floors**
- **Data mining** needs to be real time, and ongoing
- We are still **learning!**

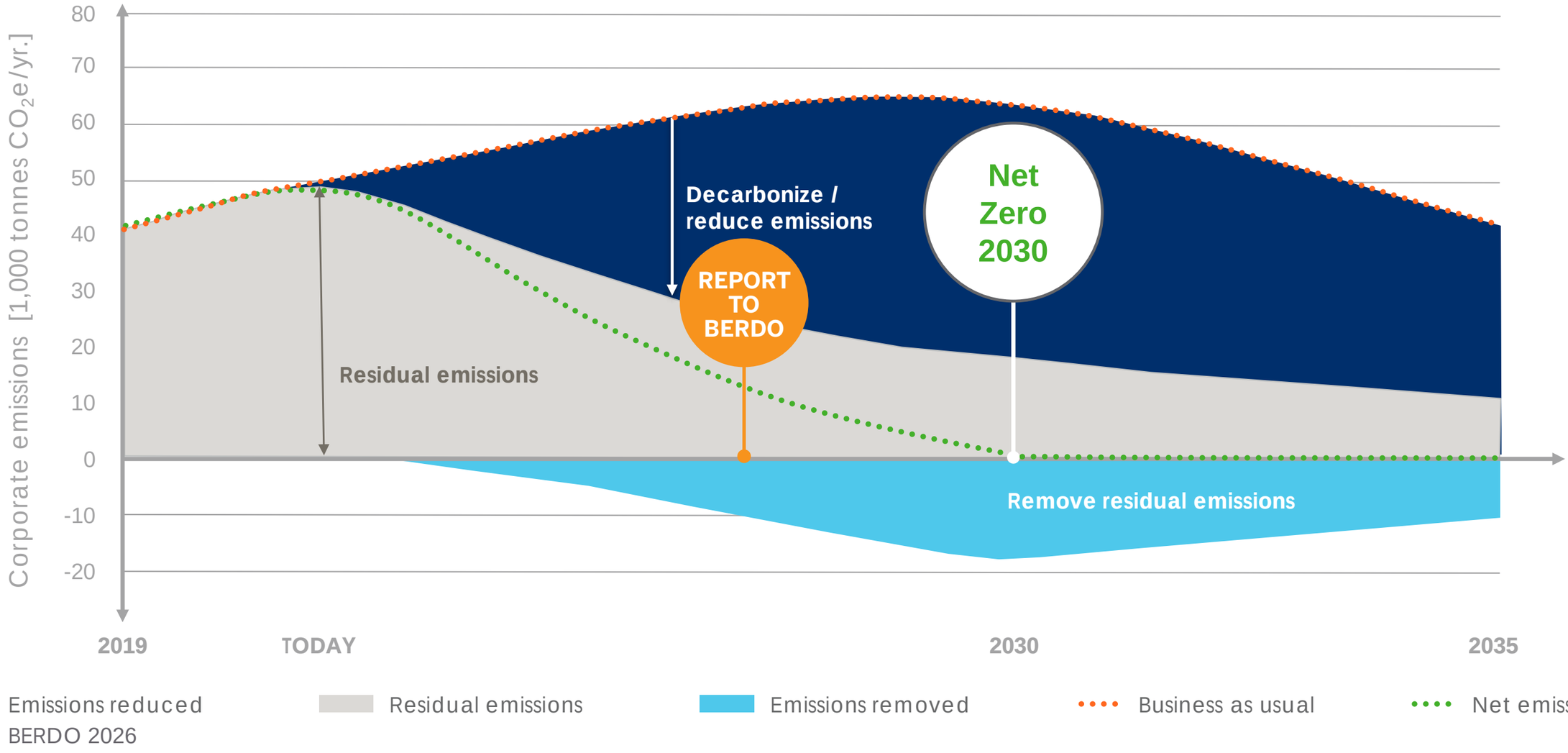
The Future

TIMELINE



The Future

MASSMUTUAL NET ZERO 2030 GOALS



The Future

BERDO — BOSTON'S BUILDING EMISSIONS ORDINANCE

2013

BERDO

Building Energy **Reporting** and Disclosure Ordinance (BERDO) required properties >35,000 sf to **report** annual energy and water use.

2021

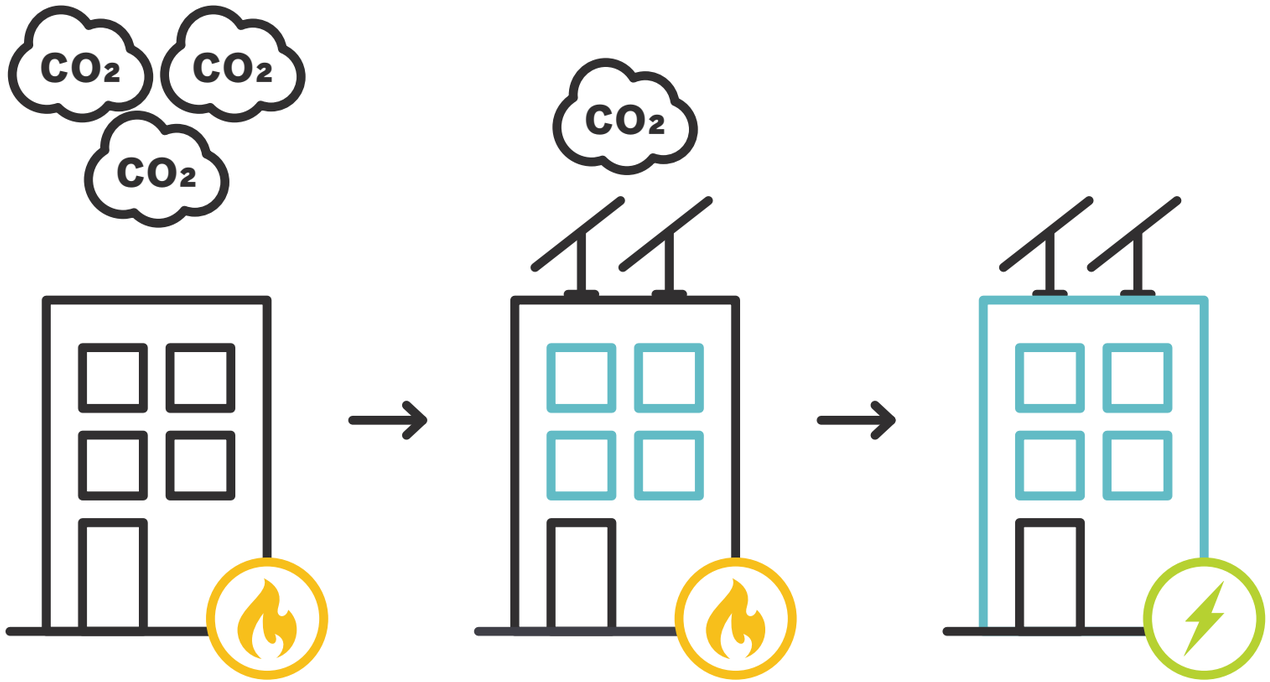
BERDO 2.0

Building Emissions **Reduction** and Disclosure Ordinance (BERDO) actively **regulates** the annual emissions of buildings >20,000 sf

The Future

BERDO — BOSTON'S BUILDING EMISSIONS ORDINANCE

- The goal is to reduce greenhouse gas emissions gradually to **net zero by 2050**
- All buildings will be held to **carbon emission limits starting in 2025**
- Building owners will need to **progressively decarbonize** their buildings



The Future

BERDO — BOSTON'S BUILDING EMISSIONS ORDINANCE

Building typology	Emission standards ($kgCO_2e/SF$)					
Year	2025–2029	2030–2034	2035–2039	2040–2044	2045–2049	2050–
Assembly	7.8	4.6	3.3	2.1	1.1	0.0
College/University	10.2	5.3	3.8	2.5	1.2	0.0
Education	3.9	2.4	1.8	1.2	0.6	0.0
Food Sales & Service	17.4	10.9	8.0	5.4	2.7	0.0
Healthcare	15.4	10.0	7.4	4.9	2.4	0.0
Lodging	5.8	3.7	2.7	1.8	0.9	0.0
Manufacturing/Industrial	23.9	15.3	10.9	6.7	3.2	0.0
Multifamily housing	4.1	2.4	1.8	1.1	0.6	0.0
Office	5.3	3.2	2.4	1.6	0.8	0.0
Retail	7.1	3.4	2.4	1.5	0.7	0.0
Services	7.5	4.5	3.3	2.2	1.1	0.0
Storage	5.4	2.8	1.8	1.0	0.4	0.0
Technology/Science	19.2	11.1	7.8	5.1	2.5	0.0

Source: Synapse model using BERDO data and historical Boston GHG emission inventories.

The Future

DECARBONIZATION APPROACHES

DEEP ENERGY RETROFITS

- Envelope
- HVAC+R
- Lighting
- Water heating
- Plug load

BUILDING-LEVEL FUEL SWITCHING

- Electrification:
  - Cooking
  - Space heating
  - Space cooling

DISTRICT ENERGY FUEL SWITCHING

- Electrification
- Low-carbon fuels

ON-SITE RENEWABLE ENERGY

- Solar PV

OFF-SITE RENEWABLE ENERGY

- Community choice electricity
- Community renewables
- Power purchase agreements
- Unbundled RECs
- Self-owned

IMMEDIATE OR **OCCUPANT TURNOVER** OR **CAPITAL IMPROVEMENTS**

The Future

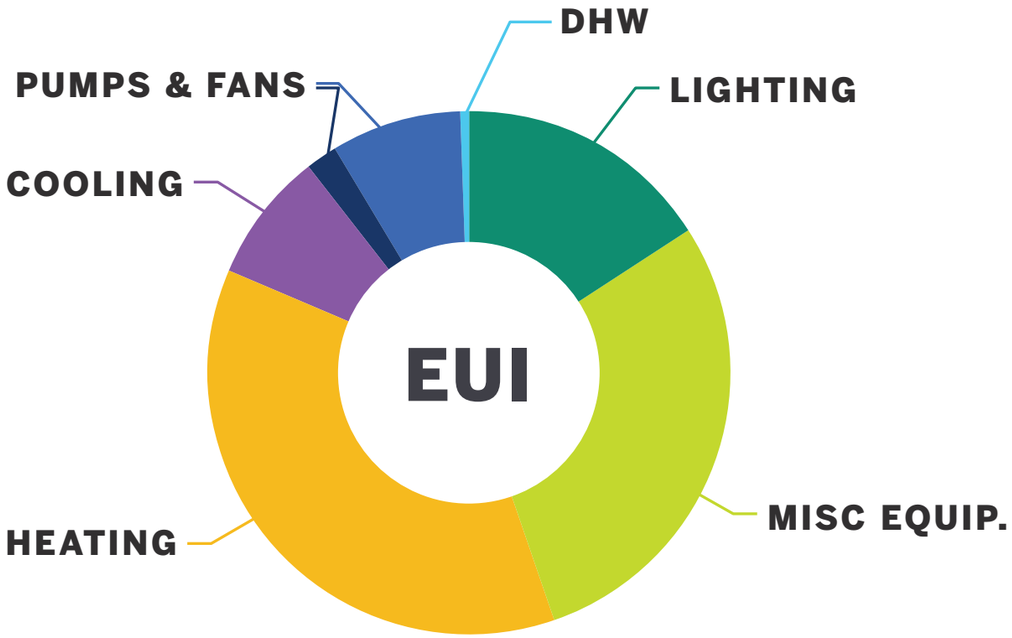
WHAT DOES THIS MEAN FOR MASSMUTUAL?

MassMutual
LIVING MUTUAL

BERDO +
2030/2050 GOALS

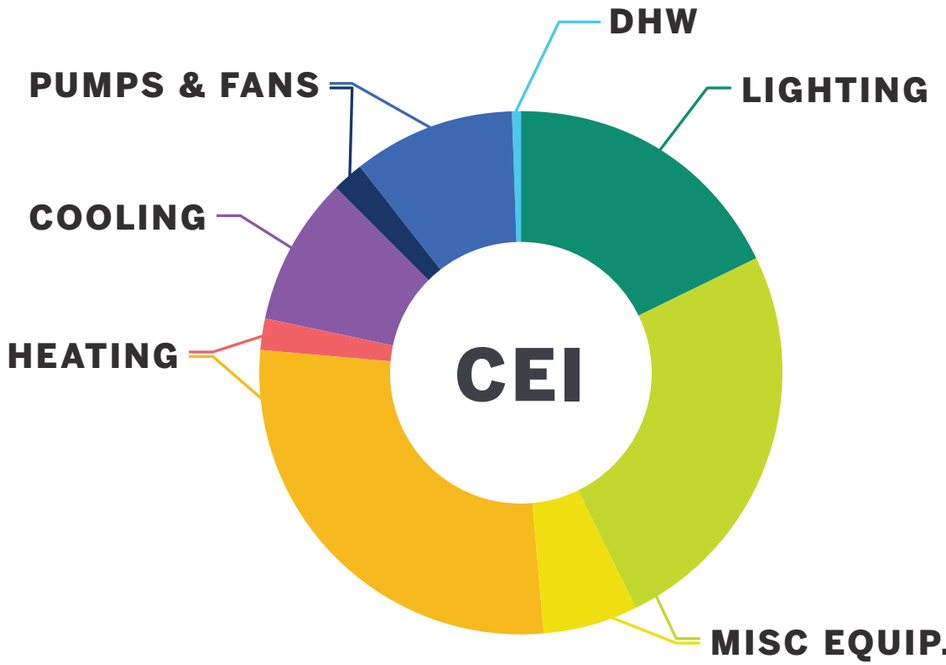
The Future

EVALUATION METRICS



pEUI (PREDICTED EUI)

Energy Use Intensity of the building, predicted via energy simulation. EUI is the building annual energy consumption,divided by the total net area of the building (kBTU/sf.yr)



pCEI (PREDICTED CEI)

Carbon Emissions Intensity of the building, predicted via energy simulation. CEI is the building annual operational carbon emissions, divided by the total net area of the building (kg CO2e/sf.yr)

The Future

CURRENT PERFORMANCE

2022

1.51

Predicted CEI

2022

2.06

Actual CEI

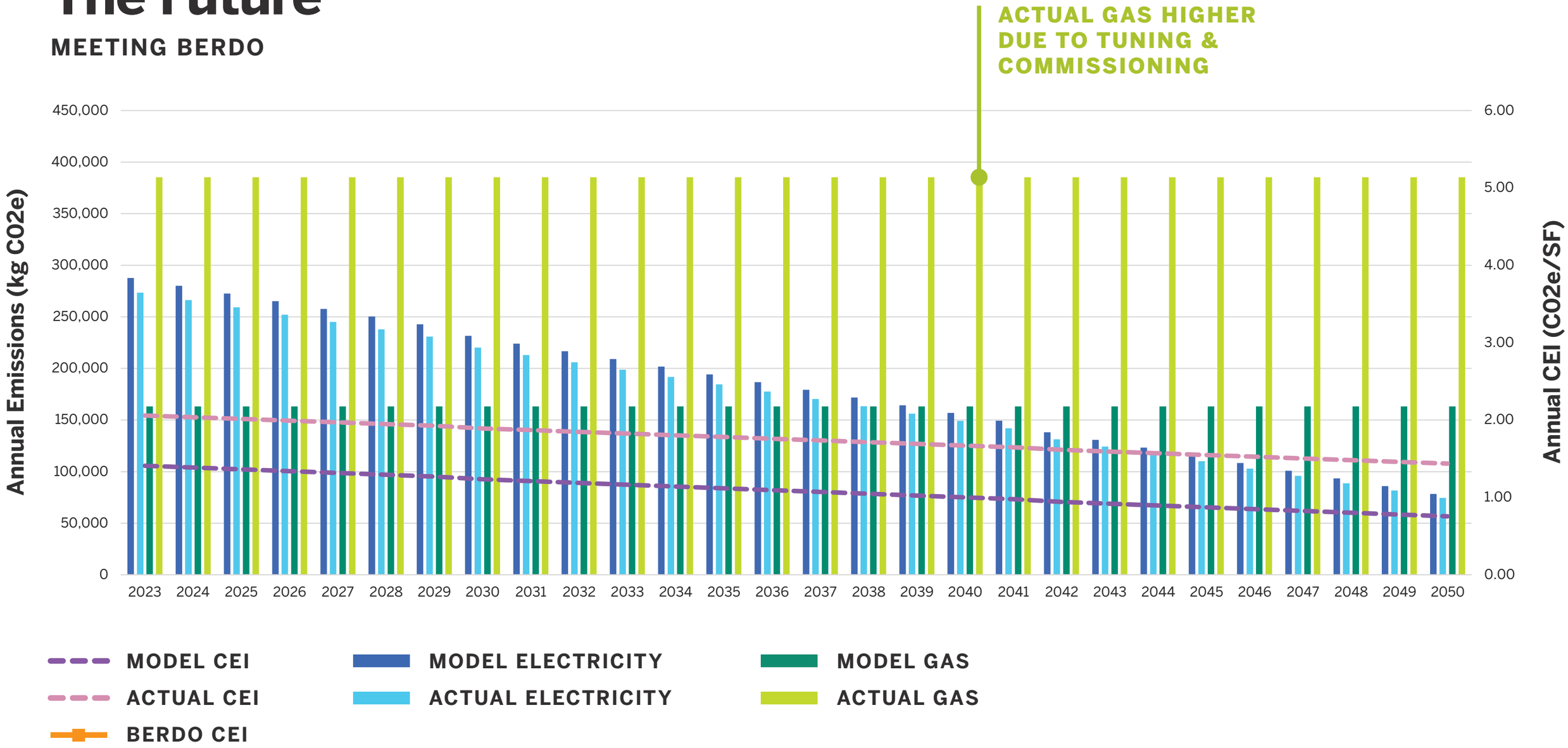
2035

1.78

2035 CEI

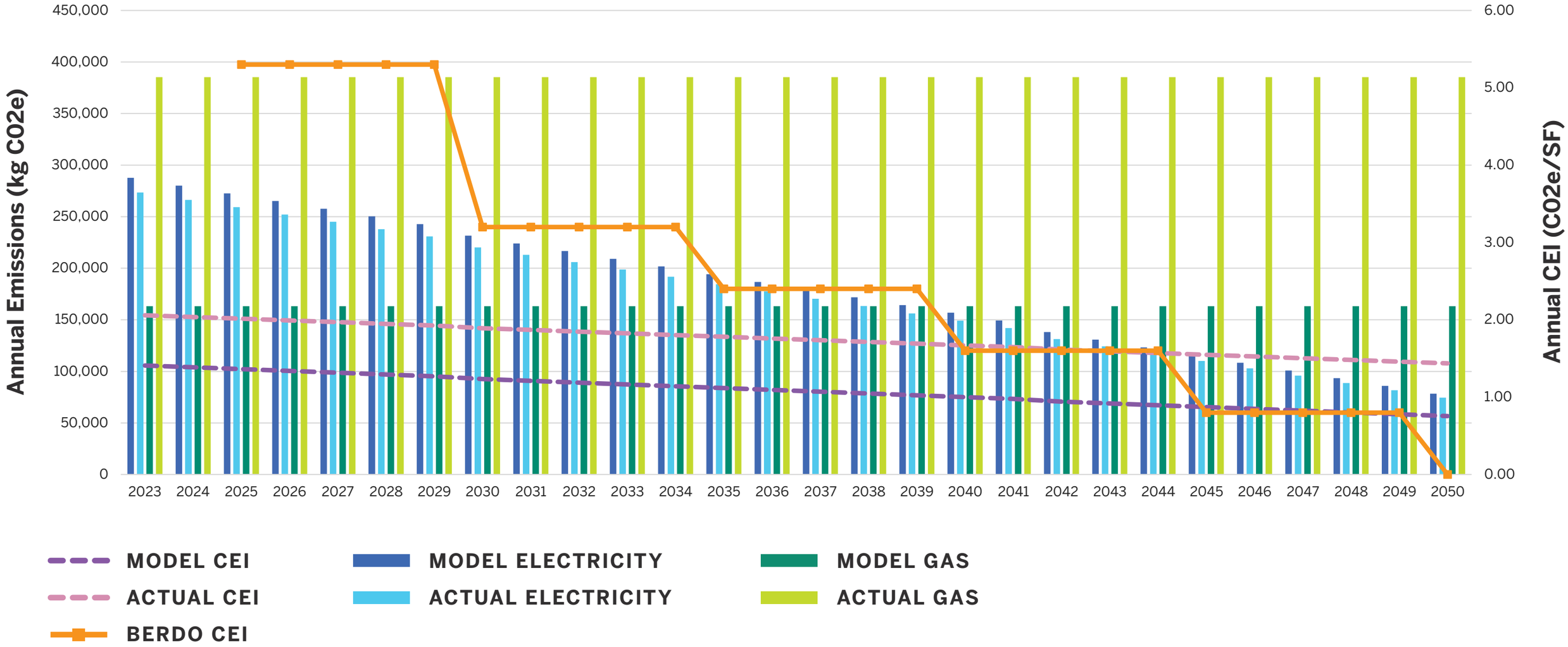
The Future

MEETING BERDO



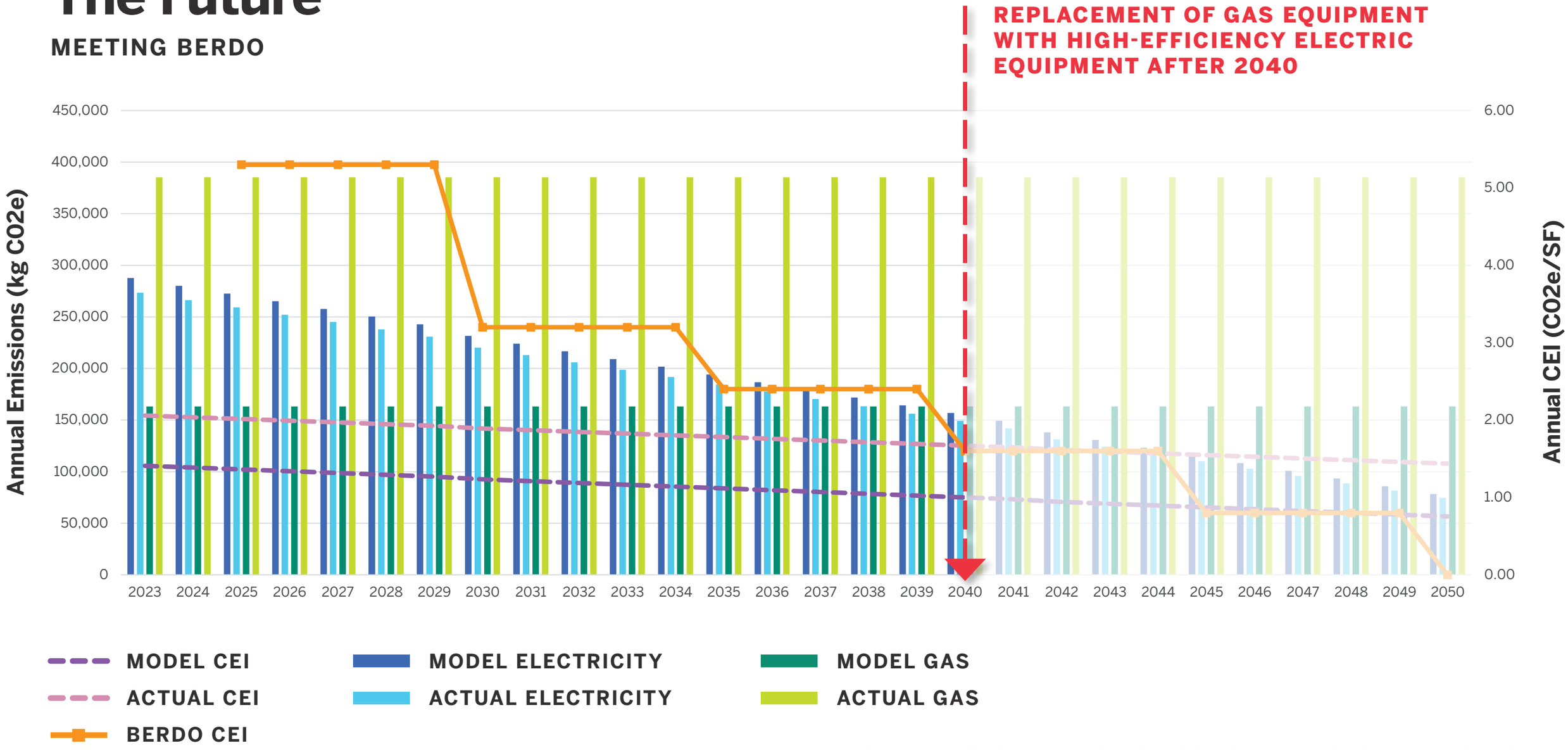
The Future

MEETING BERDO



The Future

MEETING BERDO



The Future

MEETING BERDO

Year	Actual CEI	BERDO CEI
2025	2.01	5.3
2026	1.99	5.3
2027	1.97	5.3
2028	1.95	5.3
2029	1.93	5.3
2030	1.89	3.2
2031	1.87	3.2
2032	1.85	3.2
2033	1.83	3.2
2034	1.80	3.2
2035	1.78	2.4
2036	1.76	2.4
2037	1.74	2.4
2038	1.71	2.4
2039	1.69	2.4
2040	1.67	1.6
2041	1.65	1.6
2042	1.61	1.6
2043	1.59	1.6
2044	1.57	1.6
2045	1.55	0.8
2046	1.53	0.8
2047	1.50	0.8
2048	1.48	0.8
2049	1.46	0.8
2050	1.44	0

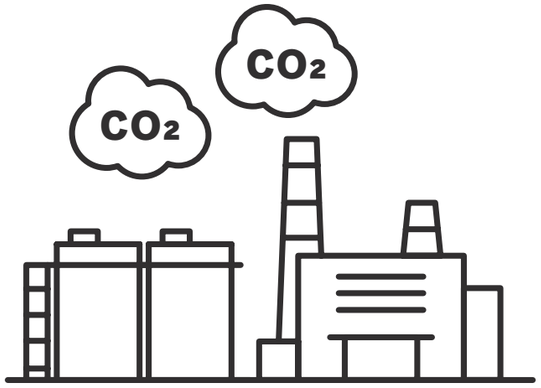
kg CO2e/sf.yr

2039	1.69	2.4
2040	1.67	1.6
2041	1.65	1.6

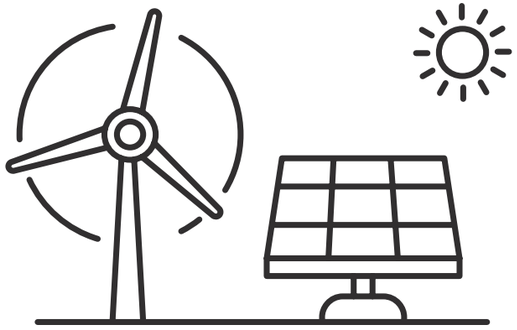
The Future

MEETING BERDO

2022	2022	2035	2040
1.51	2.06	1.78	1.67
Predicted CEI	Actual CEI	Actual CEI BERDO = 2.4	Actual CEI BERDO = 1.6

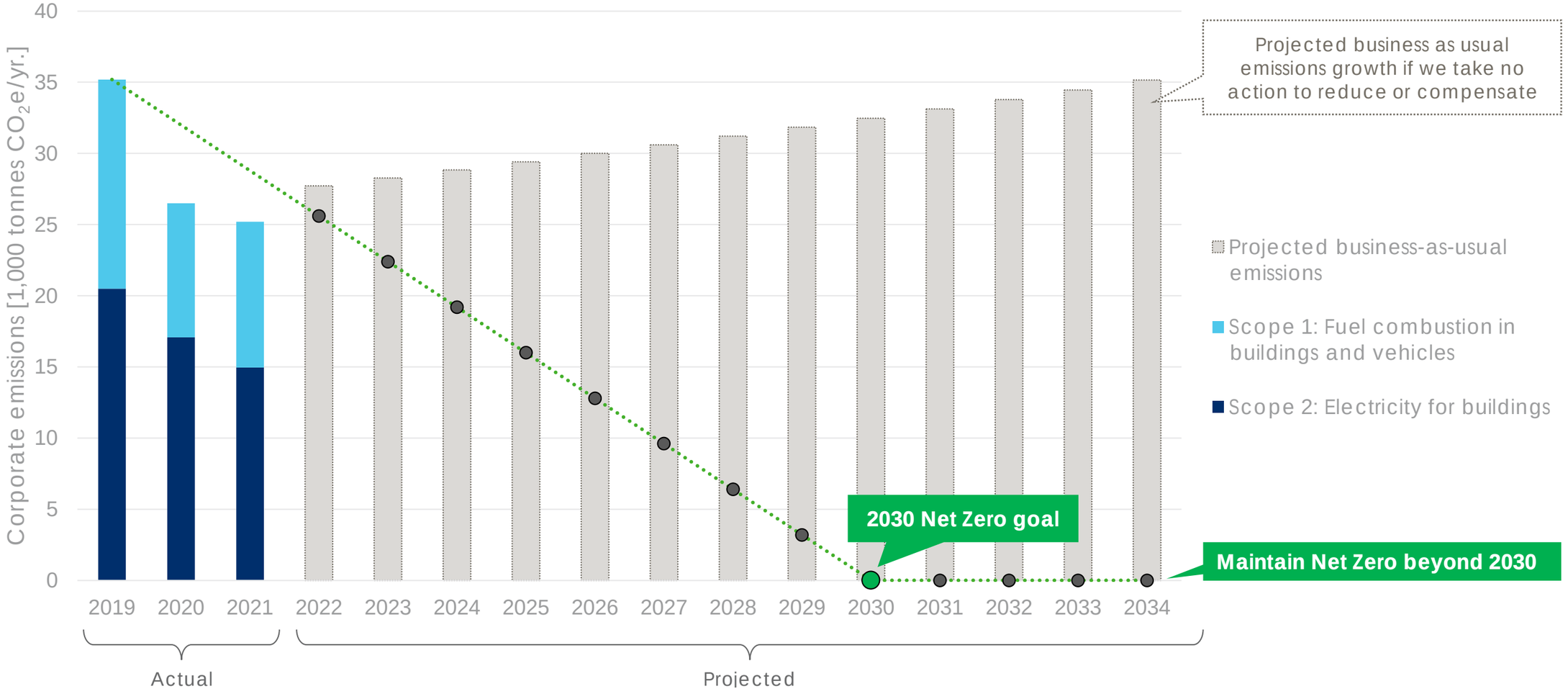


GREENER GRID

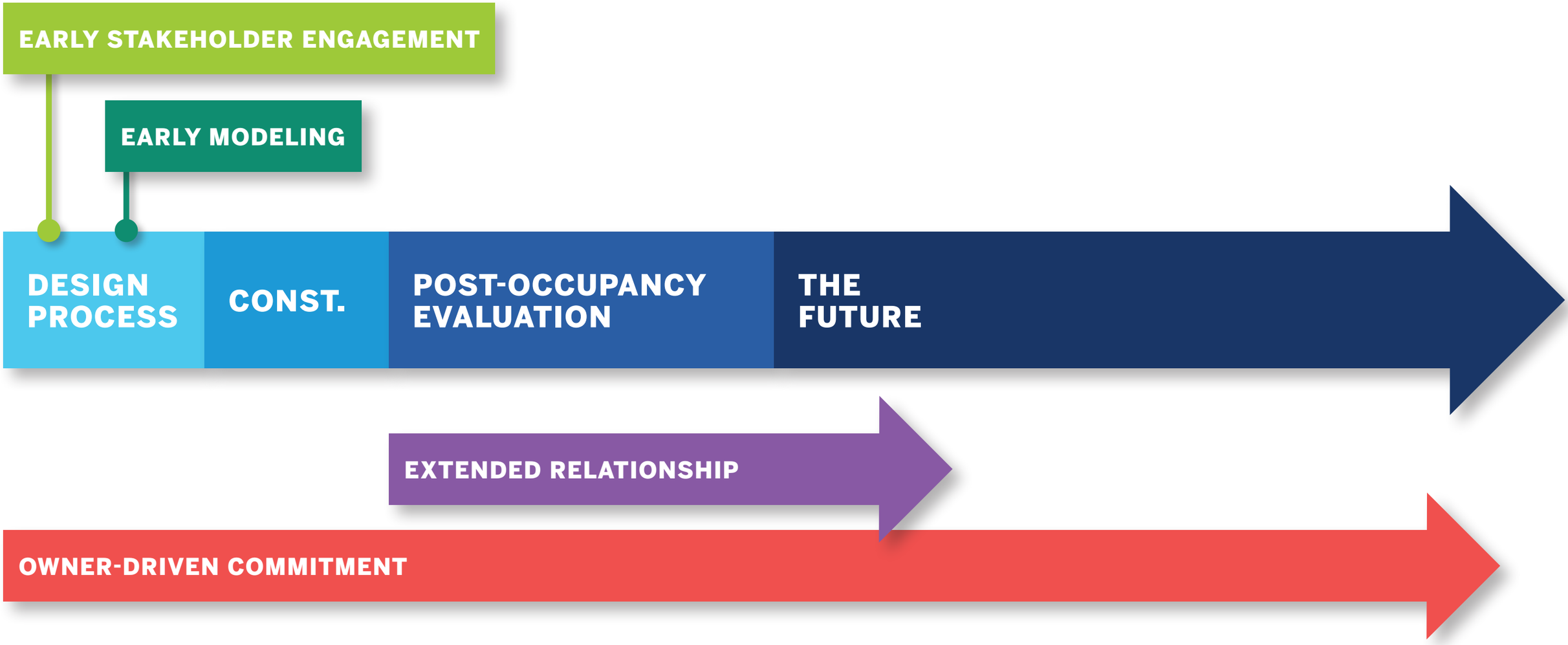


The Future

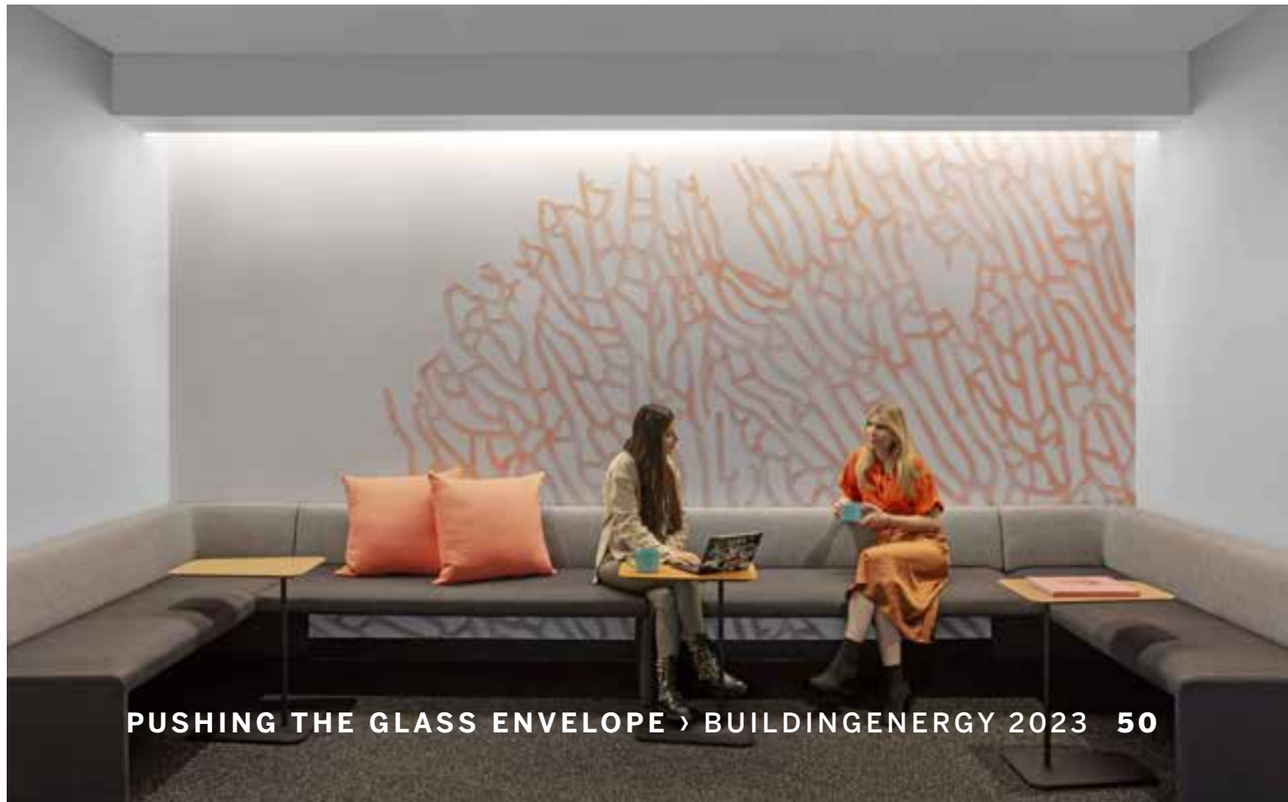
MASSMUTUAL NET ZERO 2030 GOALS



Pushing the Glass Envelope...



Q&A



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