

29585.000

BERDO Implementation & Review Board Technical Assistance

Phase 1 – Training Session 1 (90-min)

Training by RDH Building Science, Inc.

June 10, 2024



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Welcome!




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What To Expect From Today

- Recorded public session
- Many joining, Review Board is primary audience
- For questions or input from the public email: BerdoReviewBoard@boston.gov
- Zoom tools: hand raise, chat, mic muted, camera on recommended
- Informal and collaborative, engagement needed
- Opportunity for Board members to ask questions; more opportunity later as well
- Department will circulate a recording and PDF of slide deck materials



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Project Overview

RDH is supporting the City of Boston Department of Environment and BERDO Review Board with:

- + Board technical training
- + Board capacity building
- + On-call technical assistance
- + Public education materials



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About RDH Building Science Inc.

Our Services and Capabilities

Building Enclosure

- Design Consulting
- Construction Administration
- Construction Management
- Building Commissioning

Façade Engineering

- System Development
- Advanced Analytics
- Structural Engineering

Energy & Climate

- Passive House
- Energy Modeling
- Carbon Strategy

Asset Management

- Asset Planning
- Assessments
- Forensics
- Litigation and Claims



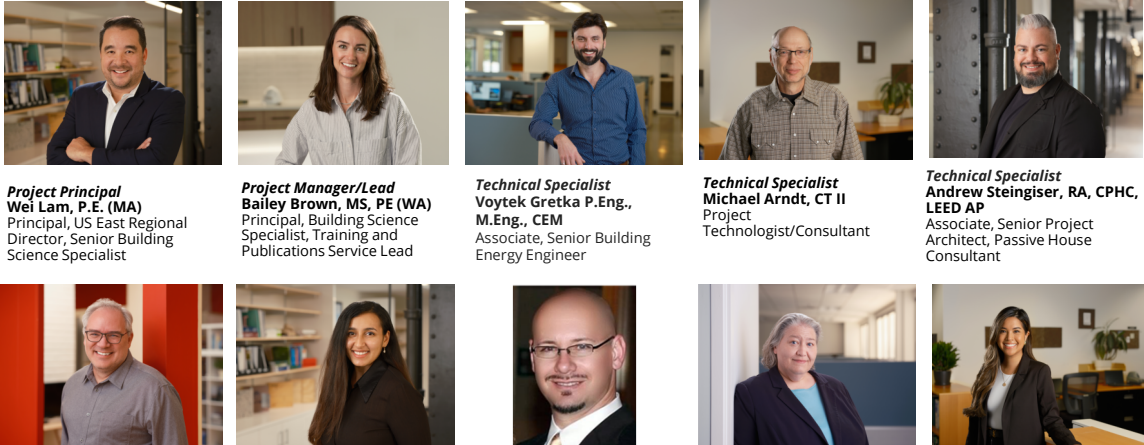
Research, Policy & Training

- Product Development
- Policy Development
- Lab Testing & Monitoring
- Industry Training + Publications



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<p>Project Principal Wei Lam, P.E. (MA) Principal, US East Regional Director, Senior Building Science Specialist</p>	<p>Project Manager/Lead Bailey Brown, MS, PE (WA) Principal, Building Science Specialist, Training and Publications Service Lead</p>	<p>Technical Specialist Voytek Gretka P.Eng., M.Eng., CEM Associate, Senior Building Energy Engineer</p>	<p>Technical Specialist Michael Arndt, CT II Project Technologist/Consultant</p>	<p>Technical Specialist Andrew Steingiser, RA, CPHC, LEED AP Associate, Senior Project Architect, Passive House Consultant</p>
<p>Technical Specialist Steve Kemp, M.A.Sc., P.Eng, LEED® Fellow Principal, Senior Energy and Sustainability Specialist</p>	<p>Technical Specialist Anushka Singh, MS, LEED GA, CPHC Energy & Sustainability Analyst</p>	<p>Lead Instructional Designer Jason Marian, MS Senior Instructional Designer</p>	<p>Technical Editor Margaret Thayer, MET Technical Editor</p>	<p>Project Coordinator Linh Lao Project Coordinator</p>

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2024 Training Overview

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Phase 1 June – July	June 10, Session 1 – Groundwork	90 min Public Meeting
	June 24, Session 2 – Audits + Beyond the Building	90 min Public Meeting
	Week of July 15 + 22, Session 3 – S1 and S2 Recap	45 min Small Cohort Training
Phase 2 Aug – Sept	Session 1	90 min Public Meeting
	Session 2	90 min Public Meeting
	Session 3	45 min Peer-to-Peer Cohort
Phase 3 Oct – Nov	Session 1	75 min Public Meeting
	Session 2	60 min Public Meeting
	Session 3	45 min Peer-to-Peer Cohort

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Training Overview – Phase 1


Phase 1 Learning Objectives

1. Introduce building science and policy fundamentals to establish a baseline knowledge for building decarbonization.
2. Explain energy audits (and alternatives).
3. Explain BERDO compliance methods and decision making.
4. Identify compliance support options that go “beyond the building” such as district energy systems, RECs, and PPAs.

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Phase 1 / Session 1 Training



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Today's Focus: Groundwork

- + Building Systems
- + Green House Gases
- + BERDO

Learning Objectives

1. Describe how a building functions as a system and the interaction between sub-systems.
2. Define the different types of building-related carbon emissions.
3. Explain why different buildings have different carbon emissions targets.
4. List building-specific factors that influence how a building may comply with BERDO.



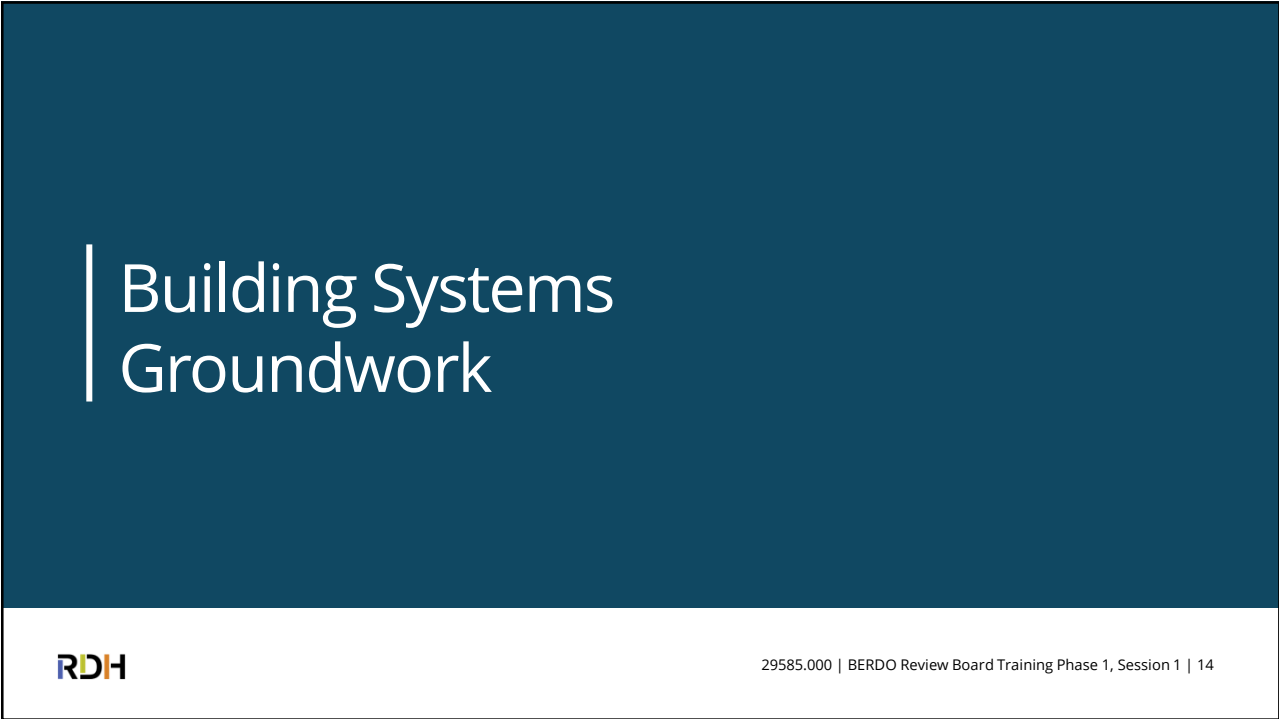
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A presentation slide with a solid olive green background. The word "Questions?" is written in white, sans-serif font, preceded by a vertical white line. At the bottom, there is a white footer bar containing the RDH logo on the left and the text "29585.000 | BERDO Review Board Training Phase 1, Session 1 | 13" on the right.

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A presentation slide with a solid dark teal background. The text "Building Systems Groundwork" is written in white, sans-serif font, preceded by a vertical white line. At the bottom, there is a white footer bar containing the RDH logo on the left and the text "29585.000 | BERDO Review Board Training Phase 1, Session 1 | 14" on the right.

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Building as a System

1. External Environment/Loads
2. Building Enclosure
3. Internal Environment/Loads
4. HVAC System
5. On-site Renewable Energy

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Illustration Source: How to Make Healthy, Low-Carbon Building Improvements, https://www.boston.gov/sites/default/files/berdo/BERDO_BuildingDecarbonization.pdf

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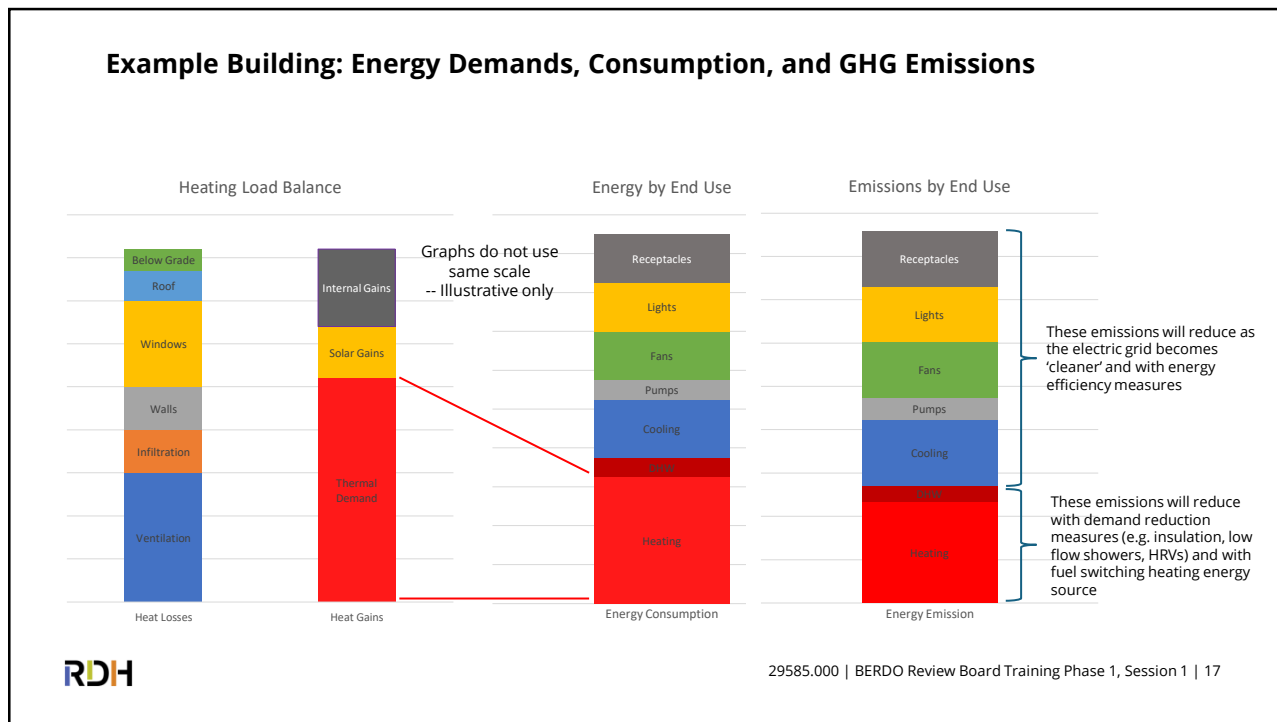
Systems: External Environment/Loads | Building Enclosure | Internal Environment/Loads | HVAC System | On-site Renewable Energy

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Illustration Source: How to Make Healthy, Low-Carbon Building Improvements, https://www.boston.gov/sites/default/files/berdo/BERDO_BuildingDecarbonization.pdf

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Building System	Building Sub-System	Regular Maintenance	Significant Intervention Maintenance	Replacement / Renewal
HVAC*	Minor HVAC Equipment e.g. fans and pumps	Monthly to Quarterly	4 to 5 years	10 to 15 years
	Primary HVAC Equipment e.g. boilers, chiller & rooftop units	Quarterly to Annually	5 to 10 Years	15 to 25 years
	HVAC Distribution e.g. hydronic piping, ductwork & terminal heating/cooling, control valves & dampers	2 to 5 years	10 to 20 years	40 to 60 years
Enclosure	Windows	2 to 5 years	10 to 20 years	20 to 50 years
	Opaque Enclosure – Roof	2 to 5 years	5 to 10 years	20 to 30 years
	Opaque Enclosure – Vertical	5 to 10 years	20 to 30 years	50 to 100 years
Structure	n/a	10 to 20 years	Every 40 – 60 years	100+ years
Controls	n/a	Monthly to Quarterly	4 to 5 years	15 to 25 years, often driven by obsolescence
Lighting System	n/a	Monthly, though annually with LED	10 to 15 Years, driven by improved lamp efficiency	15 to 20 years, driven by redesigning lighting system to take advantage of improved lamps
Electrical Service	Switchgear and Transformer	Review for capacity, overheating and conduit/insulation wear	10-15 years	50 to 70 years

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*Service hot water is typically provided with a boiler or other primary HVAC equipment and hydronic piping/distribution. These are both covered under existing HVAC sub-system categories.

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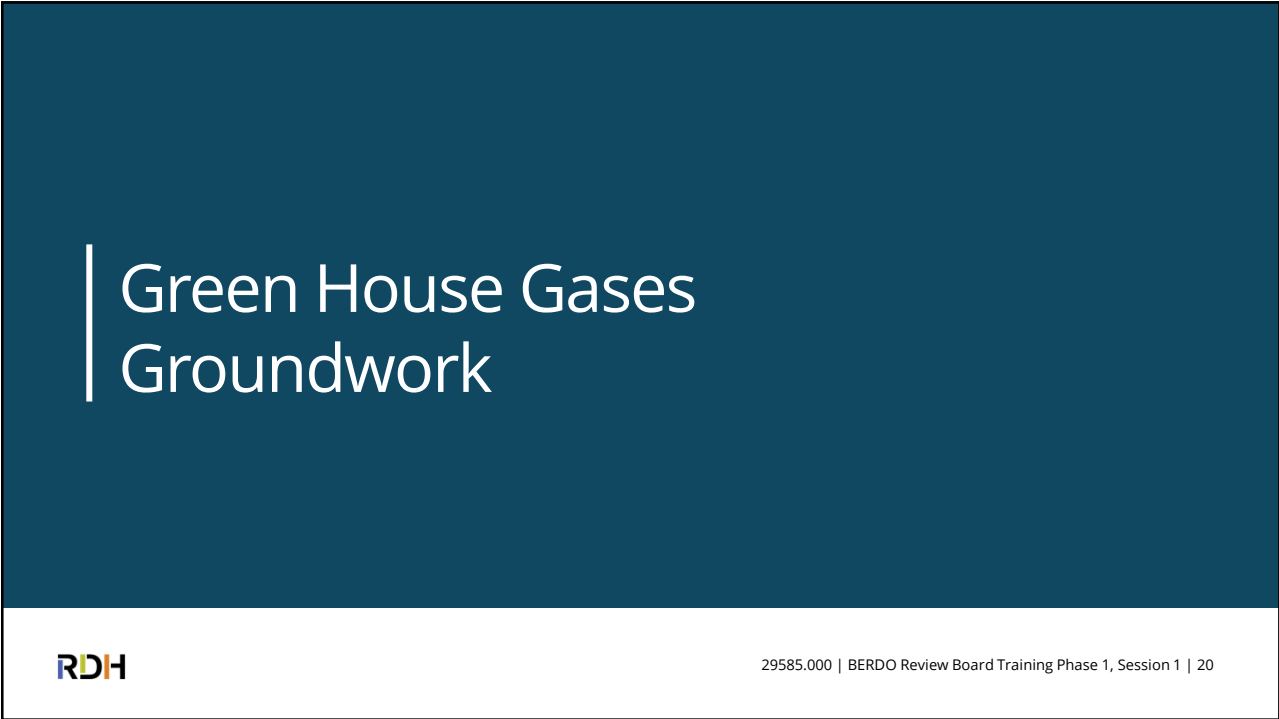


Questions?

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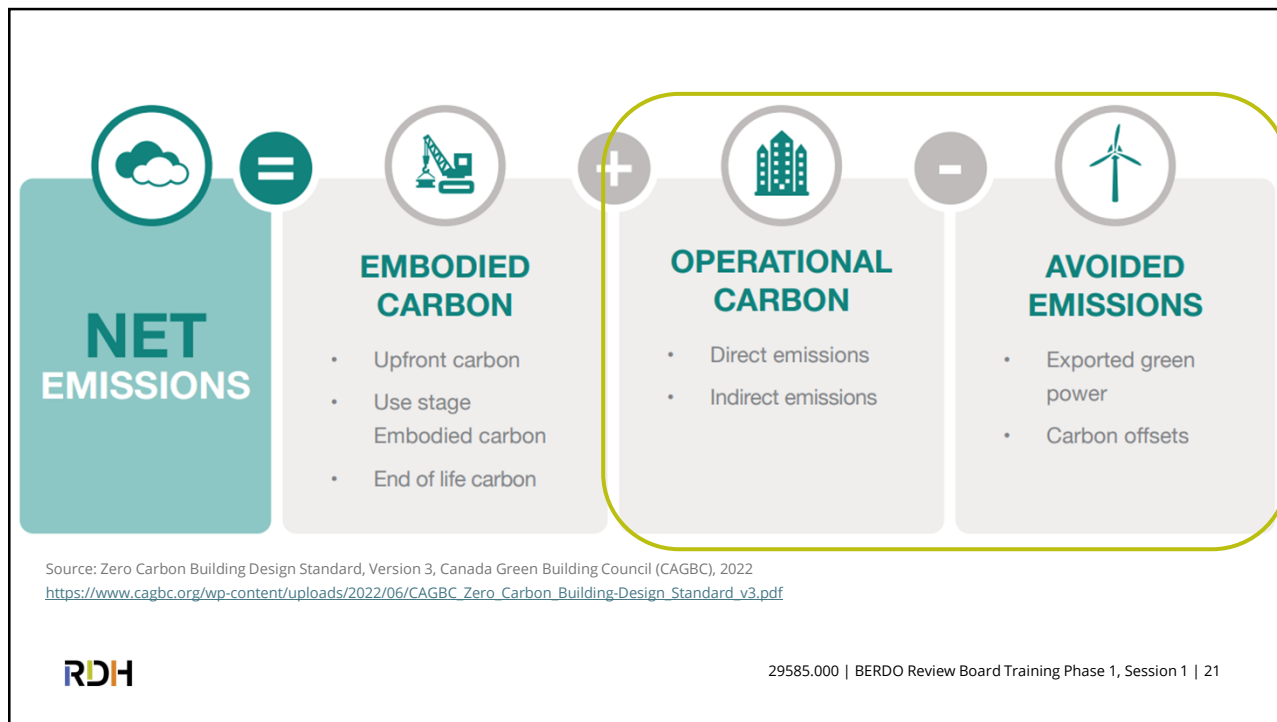


Green House Gases
Groundwork

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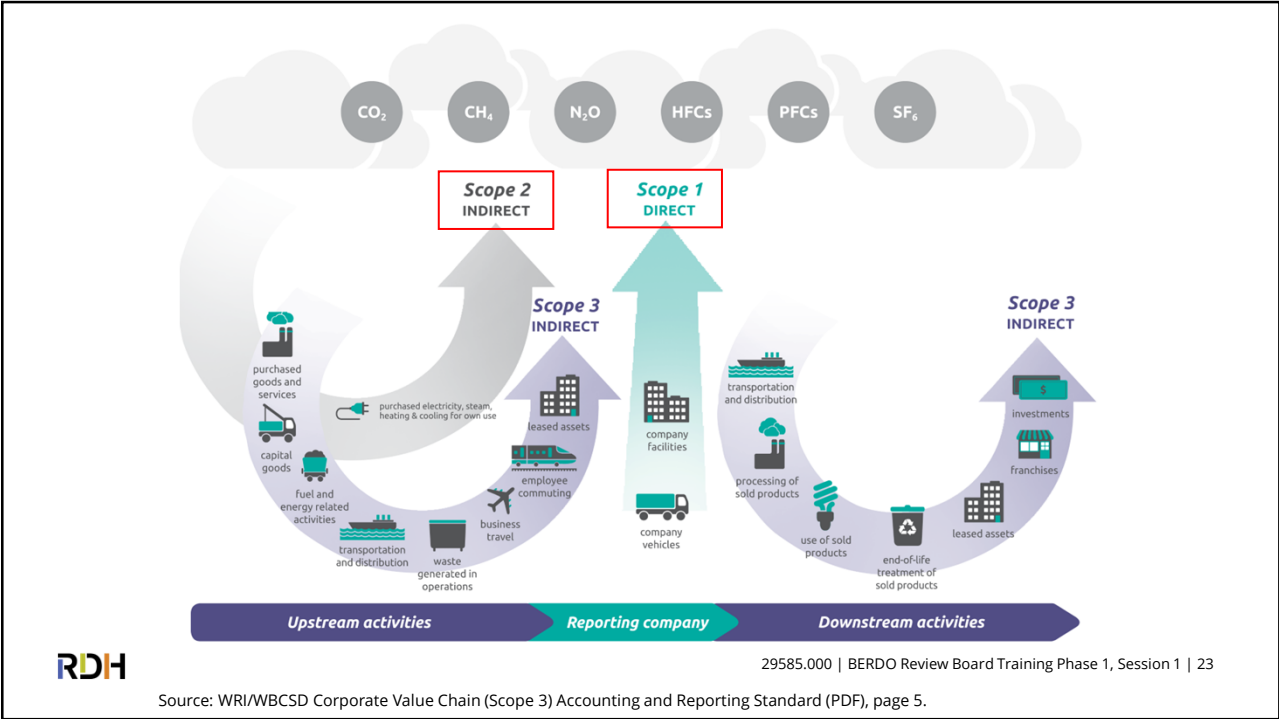
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In the chat...

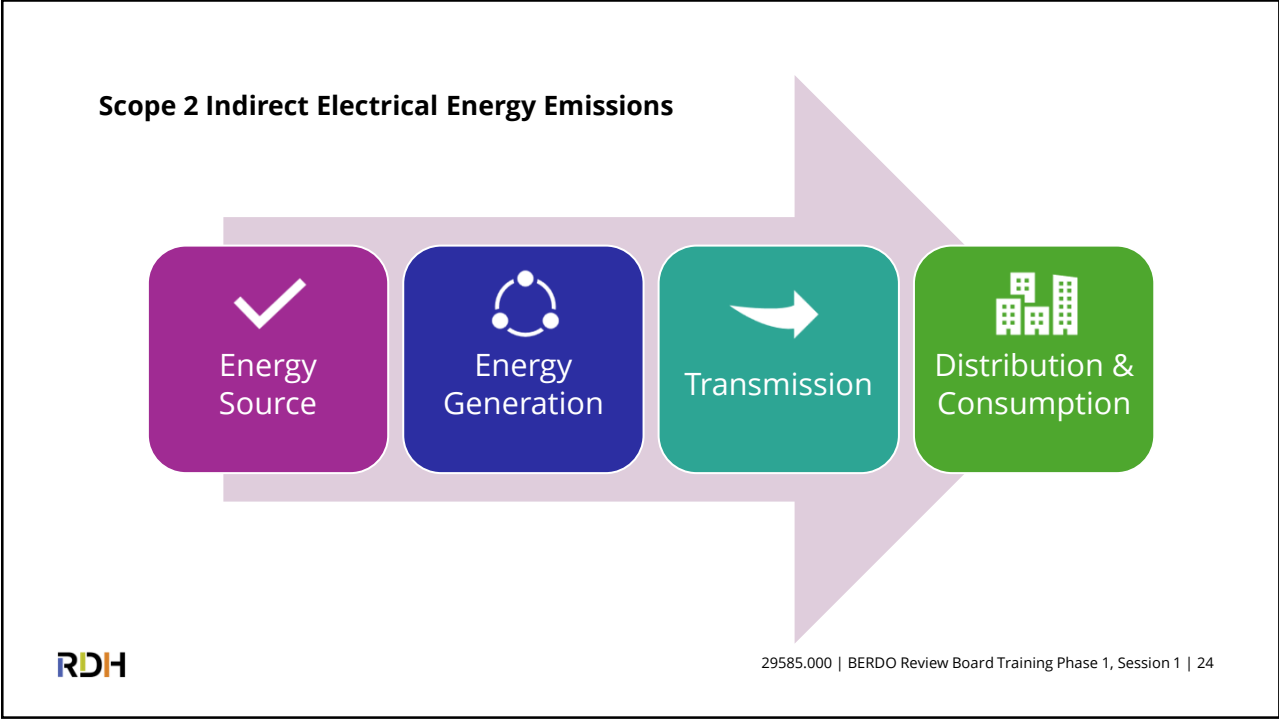
Briefly describe a few causes of building-related emissions...

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Emissions from Energy Sources

- Blend of emissions (different Green House Gases): CO₂, CH₄, N₂O, etc.
- Power is generated using different energy sources:
 - Coal, oil, gas and other fossil fuels
 - Nuclear
 - Hydro
 - Biomass
 - Wind
 - Solar
 - Geo-thermal
- Massachusetts is primary powered by gas (75.0%), Solar (9.2%)
- Emissions Factors
<https://www.boston.gov/sites/default/files/file/2024/06/BERDO%20Emissions%20Factors%20List.pdf>

Massachusetts Emissions from Resource Mix (2022)
data source: eGRID Summary Tables 2022

Energy Source	Percentage
Gas	75%
Solar	9%
Other Fossil	4%
Biomass	5%
Coal	1%
Nuclear	0%
Hydro	0%
Wind	0%
Geothermal	0%
Other	0%

Data Source: https://www.epa.gov/system/files/documents/2024-01/egrid2022_summary_tables.pdf

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Electric Grid Emissions are Changing, Natural Gas Emissions Will Likely Be Static

Assumption for Graph

- Gas Emissions: 180 kgCO₂/eMWh
- Assumed Boiler Eff: 85%
- Assumed Heat Pump COP: 2.5


Graph Based on BERDO Policies and Procedures, Projected Emissions Factors

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**Case Study:
Municipality
Administrative
Building**

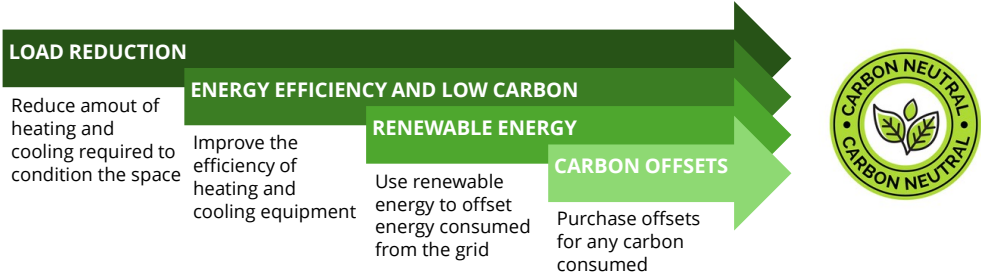


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Every Building Needs a Plan



LOAD REDUCTION
Reduce amount of heating and cooling required to condition the space

ENERGY EFFICIENCY AND LOW CARBON
Improve the efficiency of heating and cooling equipment

RENEWABLE ENERGY
Use renewable energy to offset energy consumed from the grid

CARBON OFFSETS
Purchase offsets for any carbon consumed

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Summary of Contemplated Carbon Reduction Measures

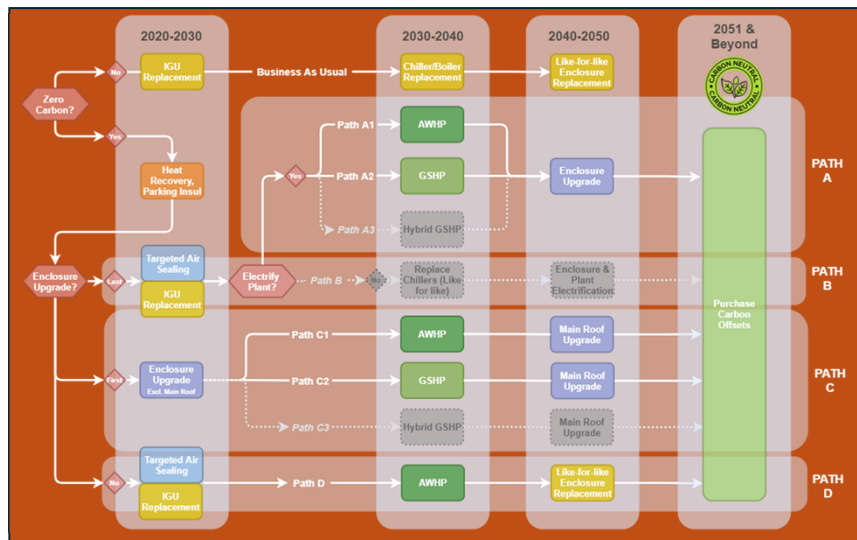
	ZERO CARBON RETROFIT PATH		BUSINESS AS USUAL PATH		
	EMISSION REDUCTION MEASURES	VALUE	REPLACEMENTS AT END OF LIFE	VALUE	
ARCHITECTURAL	WALLS	Exterior Wall Reclad with Improved Performance	R-20 Whole Wall <i>Increase exterior insulation from 3" to 8"</i>	Exterior Wall Reclad <i>Like-for-like replacement</i>	R-6 Whole Wall
		Insulate Parkade Suspended Slab	R-15 Ceiling, R-10 Walls Clear Field <i>Add 5" spray applied glass fiber insulation</i>	No Cost/Do Nothing	Uninsulated
	GLAZING	Full Glazing System Replacement with Improved Performance	U-0.15 (IP) <i>Fiberglass frame, triple glazed</i>	IGU Replacement	U-0.33 (IP) Double glazed, low e coating, argon filled
		Skylight Replacement with Improved Performance	U-0.2 (IP) <i>Triple-glazed, over-insulate the skylight curbs</i>	Skylight Replacement	U-0.67 (IP)
	ROOF	Main Roof Replacement with Improved Performance	R-40 Clear Field <i>Roof membrane replacement with 2" additional insulation (8" total)</i>	Main Roof Replacement	R-30 Clear Field
		Terrace Roof Replacement with improved Performance	R-40 Clear Field <i>Roof membrane replacement with 2" additional insulation (8" total)</i>	Terrace Roof Replacement	R-30 Clear Field
		Improved Parapet Detailing	Accounted for in Exterior Wall Reclad and Terrace Roof Replacement	No Cost/Do Nothing	N/A
	AIRTIGHTNESS	Targeted Air Sealing Improvements	2 L/s/m2 @ 75 Pa	No Cost/Do Nothing	3 L/s/m2 @ 75 Pa Assumed
		Improve Whole Building Airtightness	1.5 L/s/m2 @ 75 Pa	No Cost/Do Nothing	No heat recovery
	MECHANICAL	GENERAL	Recommissioning	N/A	Recommissioning
PLANT		Boiler Replacement with AWWP Plant	Rated Heating COP = 2.4 Rated Cooling COP = 3.0	Natural gas condensing boiler and centrifugal chiller replacement	Boiler COP=85% Chiller COP=5.2 Assumed
		Boiler Replacement with 100% GSHP Plant	Rated Heating COP = 4.1 Rated Cooling COP = 4.0		Not used
VENTILATION		Demand Control Ventilation (Occ or CO2)	N/A	No Cost/Do Nothing	No heat recovery
		Ventilation Heat Recovery - General	Sensible Eff=75% Latent Eff=55%	No Cost/Do Nothing	No heat recovery
RENEWABLE ENERGY		Ventilation Heat Recovery - Washrooms	Sensible Eff=50%	No Cost/Do Nothing	No heat recovery
		Solar PV Parking Canopy	650 kWp array 180 W/m ² panel efficiency	No Cost/Do Nothing	N/A
	Ballasted Solar PV Array at Roof	475 kWp array 180W/m ² panel efficiency	No Cost/Do Nothing	N/A	



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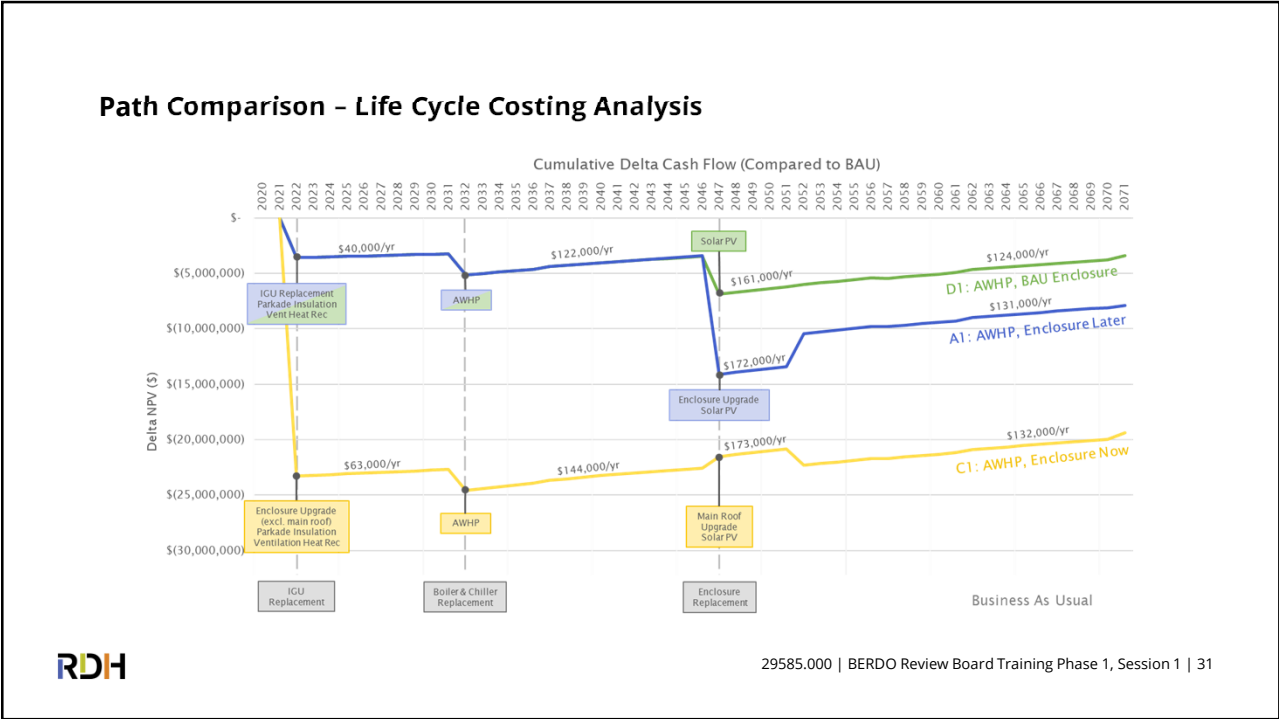
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Carbon Reduction Measures - Retrofit Roadmap

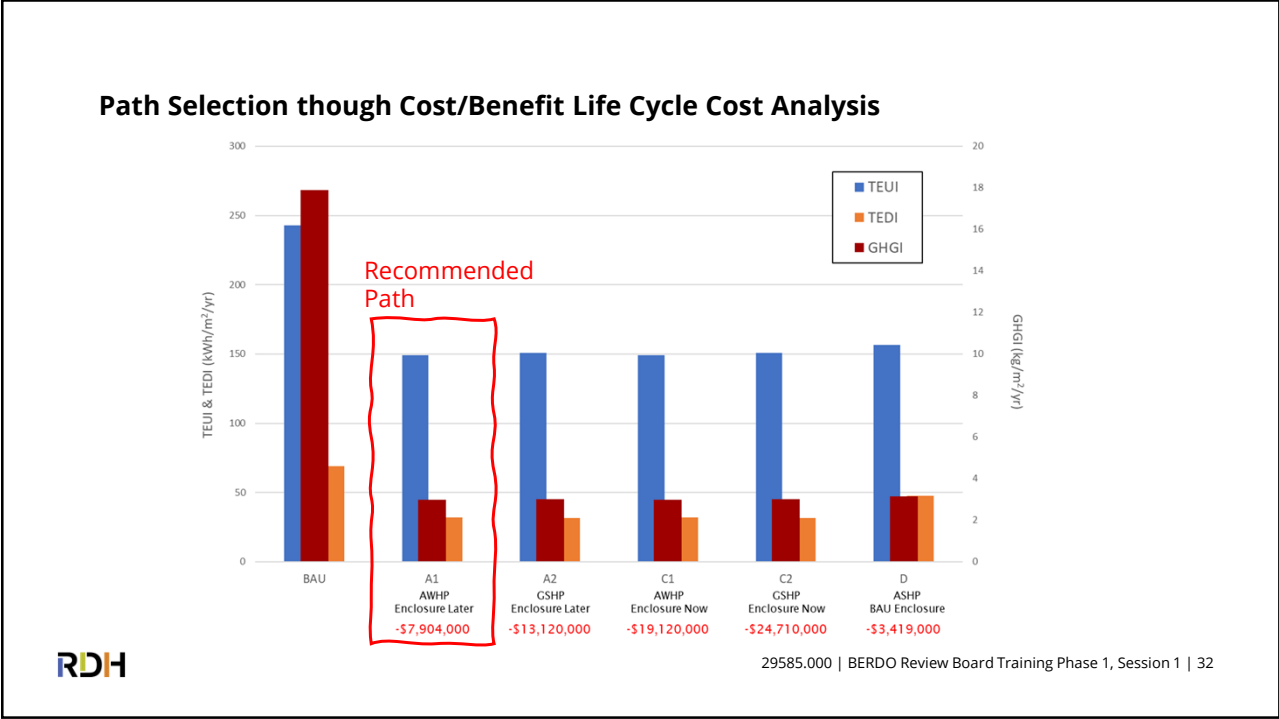


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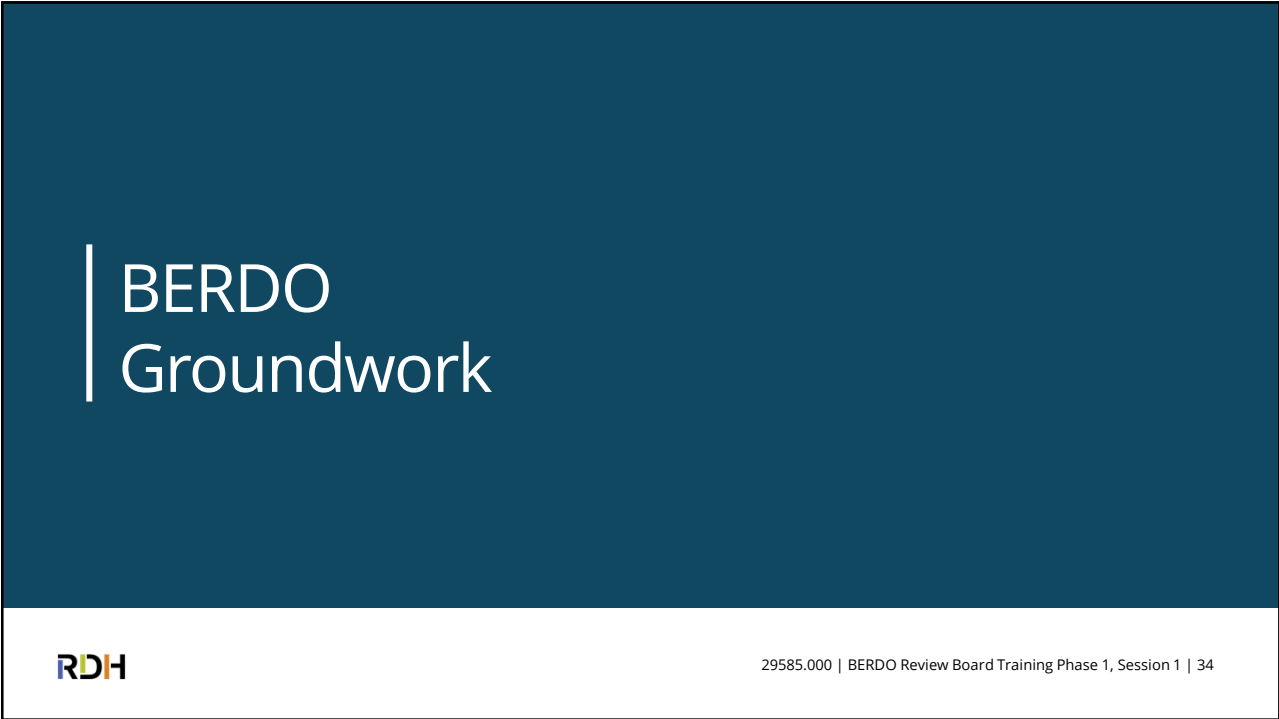


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BERDO FOCUS

The emissions standards set by BERDO decrease over time, with all buildings expected to reach net-zero carbon emissions by 2050.

BERDO encourages:

- + Retrofits
- + Energy efficiency improvements
- + Fuel switching
- + Renewable energy generation in local buildings

These improvements can increase:

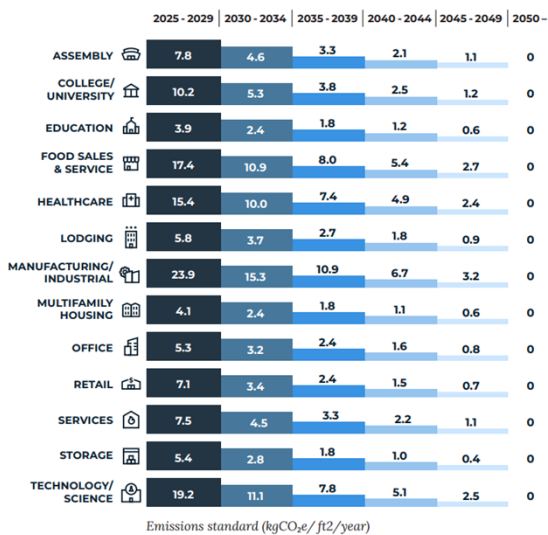
- + Thermal comfort and indoor air quality for building occupants
- + Reduce outdoor air pollution
- + Promote the hiring and development of green jobs
- + Direct further investments into building a low-carbon and equitable Boston



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USE THE CHART BELOW TO SEE YOUR EMISSION STANDARDS BY YEAR



WHAT IS AN EMISSION STANDARD?

Emissions standards, also known as emissions limits, refer to the regulated amount of climate-polluting greenhouse gases allowed to be released by BERDO buildings into the atmosphere.



Source: How to Comply with BERDO Emissions Standard: https://www.boston.gov/sites/default/files/berdo/BERDO_EmissionsCompliance.pdf

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Blended Emissions

Flexibility Measure

BLENDED EMISSIONS STANDARD

Multiply the percentage of each primary use's square footage by its associated emissions standard from the chart, then add those values together. Refer to our [Policies & Procedures](#) for detailed methodology.

Source: https://www.boston.gov/sites/default/files/file/2024/02/12.20.23%20Full%20Policies%20-%20Clean%20Version_1.pdf - Section 7

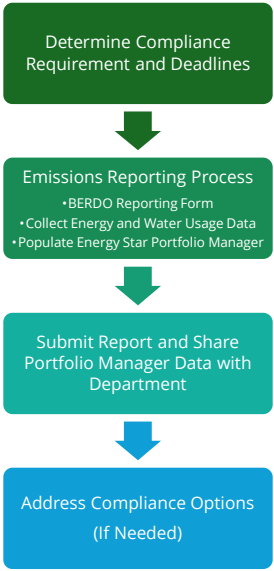


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Compliance Steps

From the owner's seat



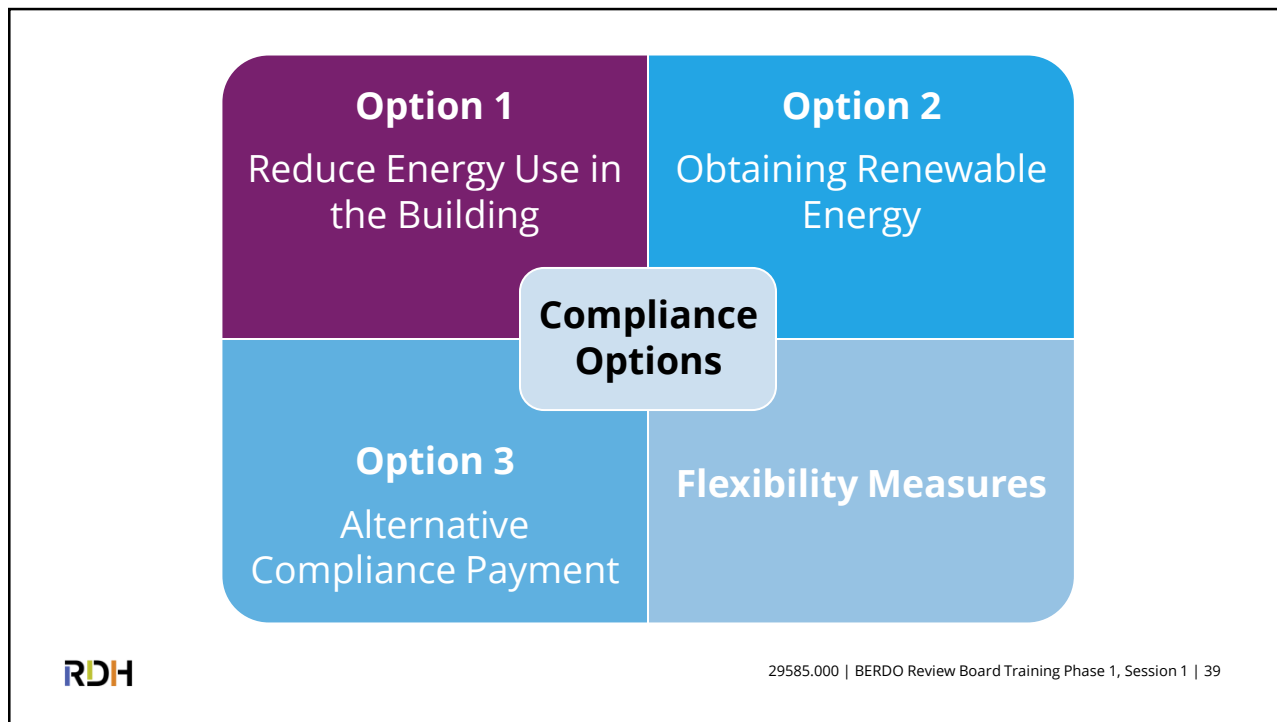
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graph TD
    A[Determine Compliance Requirement and Deadlines] --> B[Emissions Reporting Process  
• BERDO Reporting Form  
• Collect Energy and Water Usage Data  
• Populate Energy Star Portfolio Manager]
    B --> C[Submit Report and Share Portfolio Manager Data with Department]
    C --> D[Address Compliance Options (If Needed)]
  
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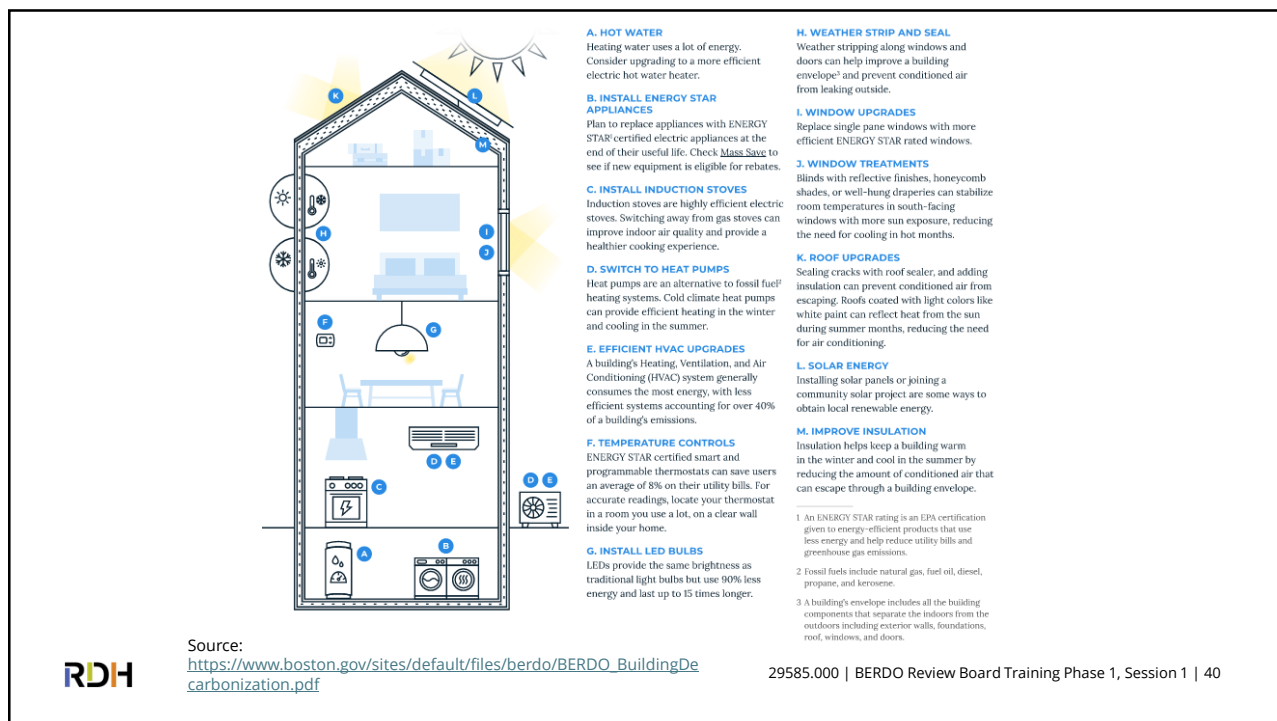


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Confounding Factors

When Reducing Energy Use in Buildings

- + Historic buildings
- + Moisture control
- + Architectural expression
- + Lot-line restrictions
- + Structural implications
- + Existing electrical capacity (building level)
- + Mechanical room sizing / supply space, acoustics
- + Retrofits triggering minimum code considerations in other areas (i.e., IAQ/ventilation)
- + Retrofits uncovering other (more major) issues that need to be addressed
- + Challenges securing capital expenditures
- + Contracting and implementation capabilities




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Option 1 Reduce Energy Use in the Building	Option 2 Obtaining Renewable Energy
Option 3 Alternative Compliance Payment	Flexibility Measures

Compliance Options




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Flexibility Measures

For Achieving Compliance

For More Information:
[https://www.boston.gov/sites/default/files/file/2023/12/Flexibility%20Measures%20\(1\).pdf](https://www.boston.gov/sites/default/files/file/2023/12/Flexibility%20Measures%20(1).pdf)



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- + Blended Emissions Standard
- + Building Portfolio
- + Individual Compliance Schedule
- + Hardship Compliance Plan

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| Questions?



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Review Board Learner Survey

Duration: 1 minute



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Next Steps...

- Phase 1 Session 2 Training – June 24th
Learning Objectives
 - Define the purpose and steps of an **energy audit**.
 - Describe why **every building needs a decarbonization plan** and the attributes of a good plan.
 - Define **district energy systems**.
 - Describe **PPAs** and the steps required to sign up for a PPA.
 - Describe **RECs** and when they are an appropriate solution for compliance.
- Small Cohort Training
 - Confirmed week of June 17th
 - Scheduled for 3rd and 4th week of July

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