Leading by Example Council Agenda
September 14, 2021

- Welcome
- LBE Updates
- Clean Energy News
- State of the Climate: IPCC Report
- State of the LBE Portfolio
- Heat Pumps 101

UMass Amherst Named One of Nation's 'Coolest Schools'

Notable UMA accomplishments highlighted by Sierra Club include:

- Home to the state's first fast-charging EV station, with plan to transition entire fleet to EVs
- Three solar canopies and five rooftop systems, with two more canopies on the way, that will total 10 MW
- Task force of students, faculty and staff who are creating a plan to move UMA toward zero carbon emissions
- Early adopter of the Carbon Literacy Project, hiring undergrads to facilitate a training on costs of carbon and solutions to the climate crisis
- Expansion of a regional bike-share program
- Awarded grant to study nexus of energy and equity in era of climate change

UMA ranked 18 out of 328 in Sierra Club's review of North America's greenest colleges and universities

Source: Sierra Club

A view of the Campus Center from the green roof on the new Integrative Learning Center. | Photo by John Solem/University of Massachusetts Amherst

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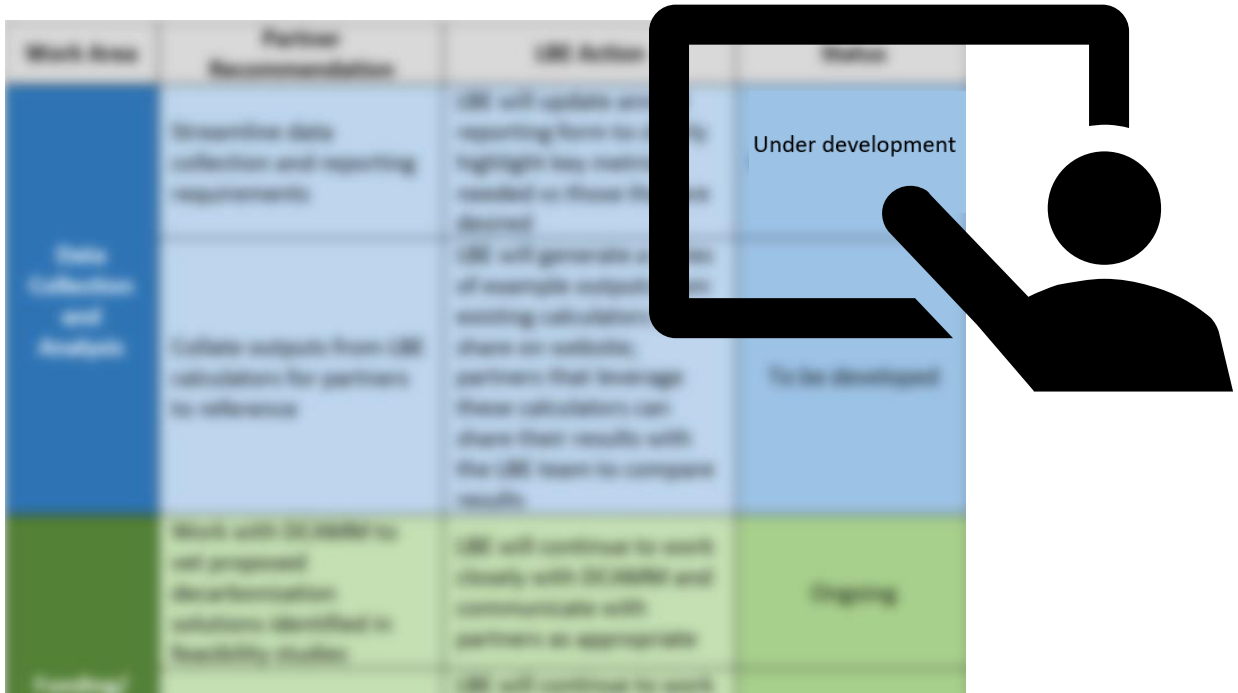
LBE Updates & Clean Energy News

July Council Meeting Action Items

- State partner feedback captured from breakout discussion groups regarding LBE Program tools, guidance, technical assistance, and other support
- Staff developed internal action plan based on suggestions
- Report-out at next LBE Council meeting



2021 Leading by Example Awards

Awards are presented to:

- ✓ Two state agencies
- ✓ Two public institutions of higher education
- ✓ Two municipalities
- ✓ One staffer or volunteer from a state entity
- ✓ One staffer or volunteer from a municipality

New this year!

Nominations will be accepted in two phases:

- **Phase 1**: Express Interest Forms (for entities)
- **Phase 2**: Full Nomination Forms (for entities and individuals)

Entities are *highly encouraged* to complete Phase 1. DOER staff will review these forms and offer input before encouraging compelling applicants to submit a full nomination form.

2021 LBE Awards

Find all of this information, including this handy flyer, at www.mass.gov/LBEAwards

The deadline for Express Interest Forms is Friday, September 24th

The deadline for Full Nomination Forms is Friday, October 22nd

Visit www.mass.gov/LBEAwards for more information

FY21 LBE Tracking Form Update *(yes, it's almost that time…)*

- Release date: September 30th
- Submission deadline: December 31st
- New features include:
  - ✓ Enhanced fleet reporting
  - ✓ Section removal / consolidation
  - ✓ Increased automation
- If anyone wants to volunteer as tribute to review and provide user feedback, please reach out to Chelsea!

EO 594 Guideline Updates

- Additional information and clarifications to support implementation

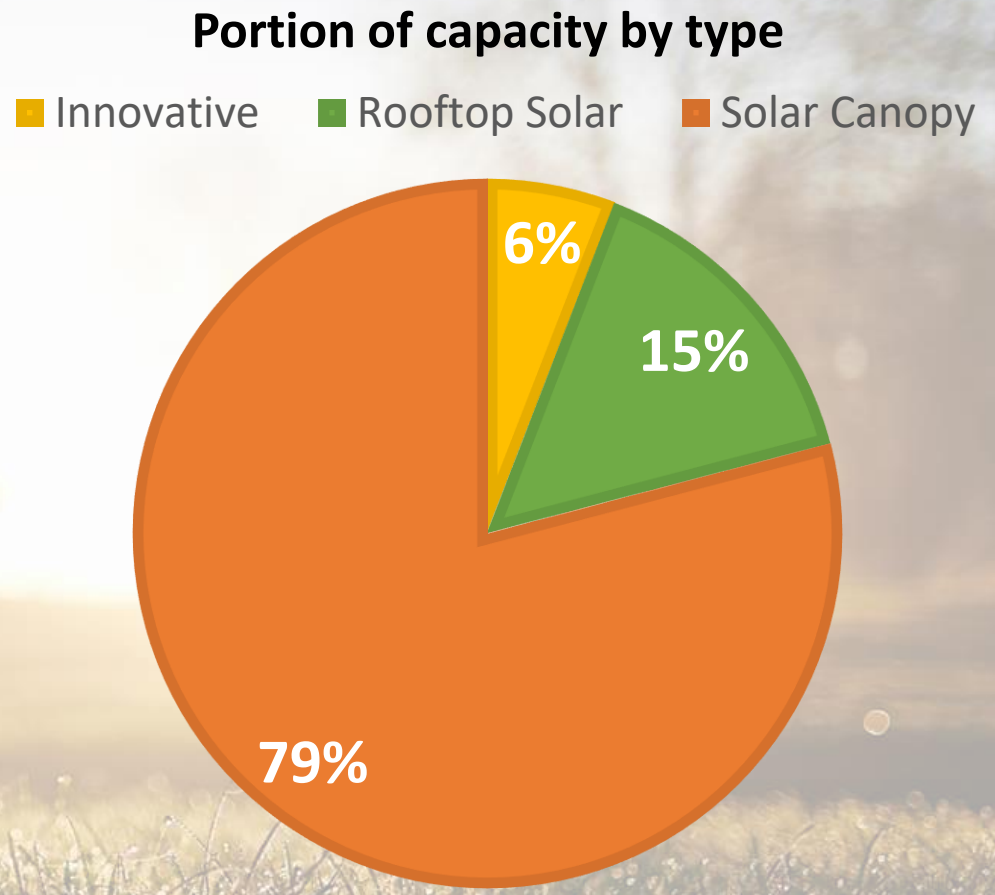
Publishing soon	**Stakeholder comment process**	*Coming this fall*
New construction	ZEV acquisitions	Existing buildings
Biofuels	EV charging infrastructure	Calculating progress
Program administration		Sustainability priorities
		Renewables

LBE Solar Grant III Wrap-up

$4.9M awarded

- 10.89 MW solar
- 3.3 MW storage
- 13 million kWh annually

		
8 canopies	**6 rooftops**	**1 innovative**



Sampling of New and Upcoming EV Models

Sedans, Crossovers, & SUVs	Pickup Trucks	Vans & Specialty Vehicles
• Nissan Ariya (2021) • Volvo C40 Recharge (2021) • Mazda MX-30 (2021) • Hyundai Ioniq 5 (2021) • Kia EV6 (2022) • Ford Explorer EV (2023) • Honda Prologue (2024)	• Ford F-150 Lightning (2021) • Rivian R1T and R1S (2021) • Chevy Silverado Electric (2023) • Ram 1500 EV (2024)	• Ford E-Transit (2021) • Canoo (2022)

Statewide Contract Updates

VEH110 -- Light and Medium Duty Vehicles

Replaces VEH98

- Accepting bids through **October 13th at 2pm**
- Estimated contract start date: **December 1st, 2021**
- More competitive; new category distribution and requirements; preference given to ZEVs

★ **Only ZEV/HEV models being sought for sedan, minivan, and SUV categories** ★

VEH111 -- Heavy Duty Vehicles & On-Road Construction

Replaces VEH93

- Estimated contract start date: **November 1st, 2021**
- New category distribution, preference given to ZEVs and AFVs

2022 Ford E-Transit

Now available on VEH98!

Ford E-Transit Cargo Van	
Engine Type	All electric
Electric Range (mi.)	126
Seating Capacity	2
Cargo Space (cu. Ft.)	487
Drive Train	RWD
Max. Horsepower	266
Max. Torque (lb.-ft.)	317
Max. Payload (lbs)	3,800
Battery Warranty	Standard
Expected Starting MSRP	$45,000

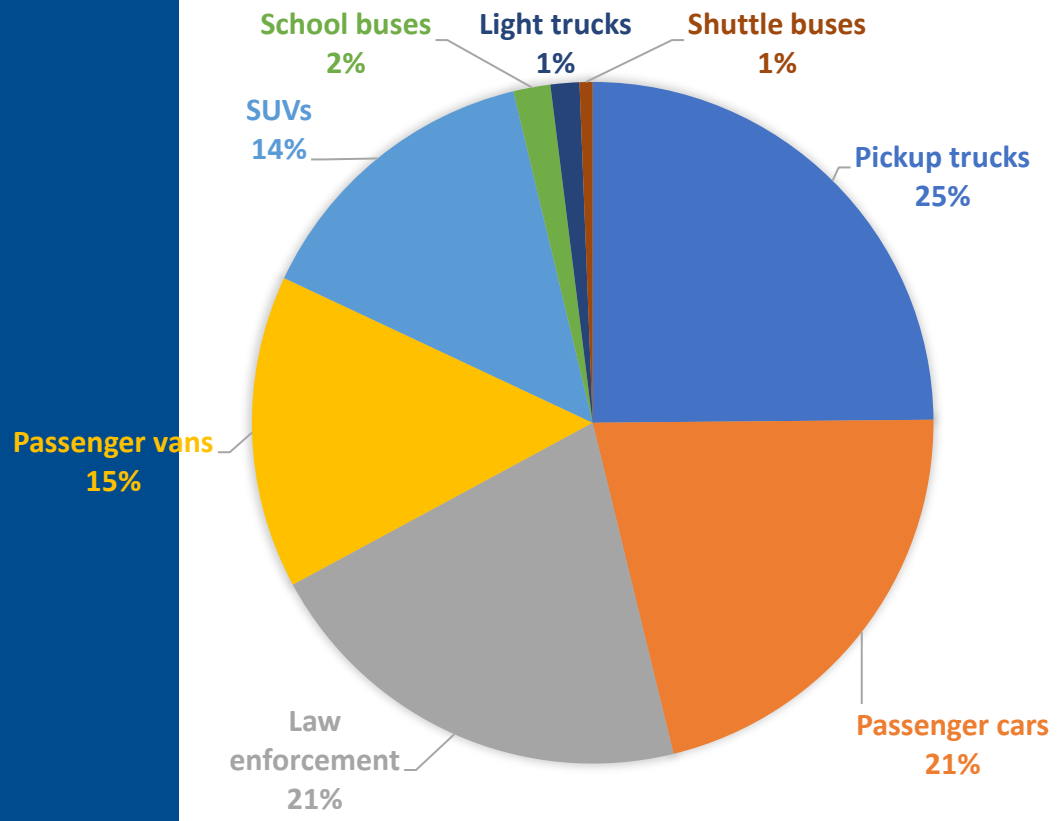
Highlighted Features…

- 3 roof heights and body lengths
- Chassis cab & cutaway models
- 2.4 kW of onboard power
- Rear-shelf delete option

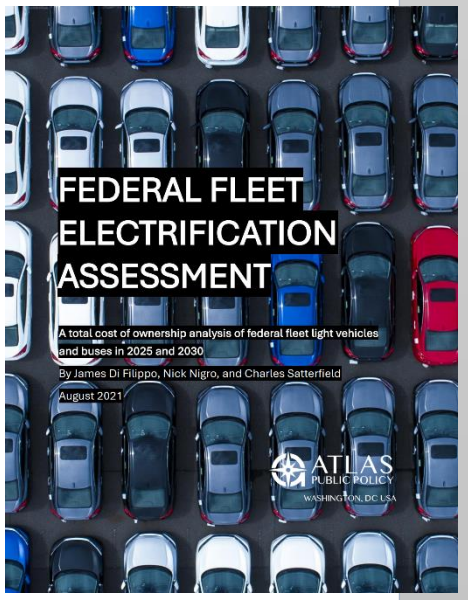
Funding support available through MassEVIP Fleets & MOR-EV Trucks programs

Important Note: MassEVIP funding approval must be received before purchased orders are placed!

An Analysis of Electrifying the Federal Fleet



USPS fleet electrification could yield as much as $4.3B in lifetime savings

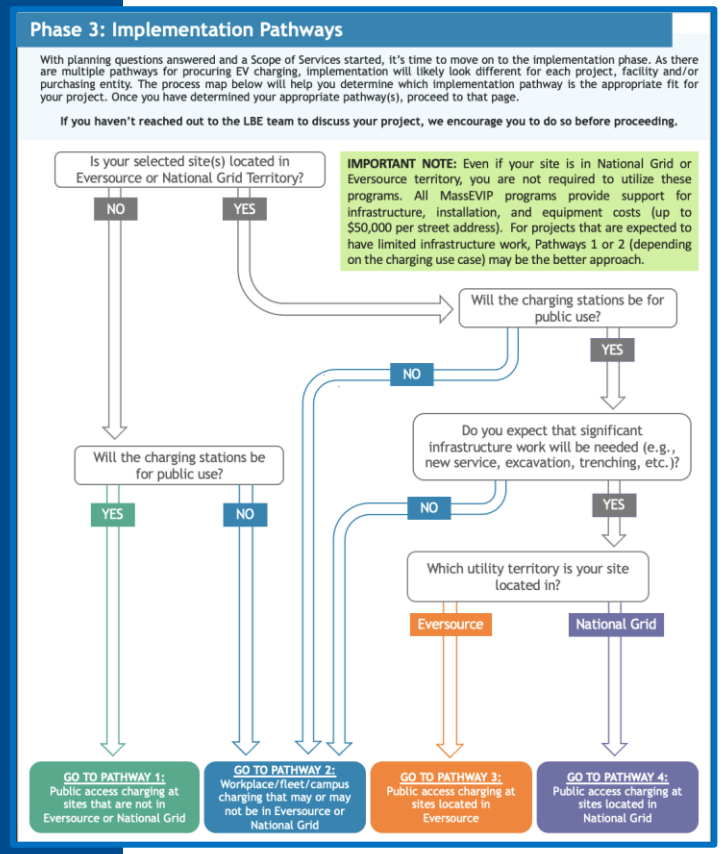


Report

- Third party report assessed federal government fleet, which is the largest in the US
- Suggests that between 2025-2030 a growing percentage of federal vehicles could be replaced with EVs at a lower TCO, with the vast majority being cost competitive by 2030
- Non-USPS fleet EVs could yield lifetime savings of as much as $1.18B
- Report quantifies reinvestment of savings and public benefits of more rapid electrification

New EV Charging Station Resources

Procurement roadmap



Phase 3: Implementation Pathways

With planning questions answered and a Scope of Services started, it's time to move on to the implementation phase. As there are multiple pathways for procuring EV charging, implementation will likely look different for each project, facility and/or purchasing entity. The process map below will help you determine which implementation pathway is the appropriate fit for your project. Once you have determined your appropriate pathway(s), proceed to that page.

If you haven't reached out to the LBE team to discuss your project, we encourage you to do so before proceeding.

Is your selected site(s) located in Eversource or National Grid Territory?

NO — Will the charging stations be for public use?

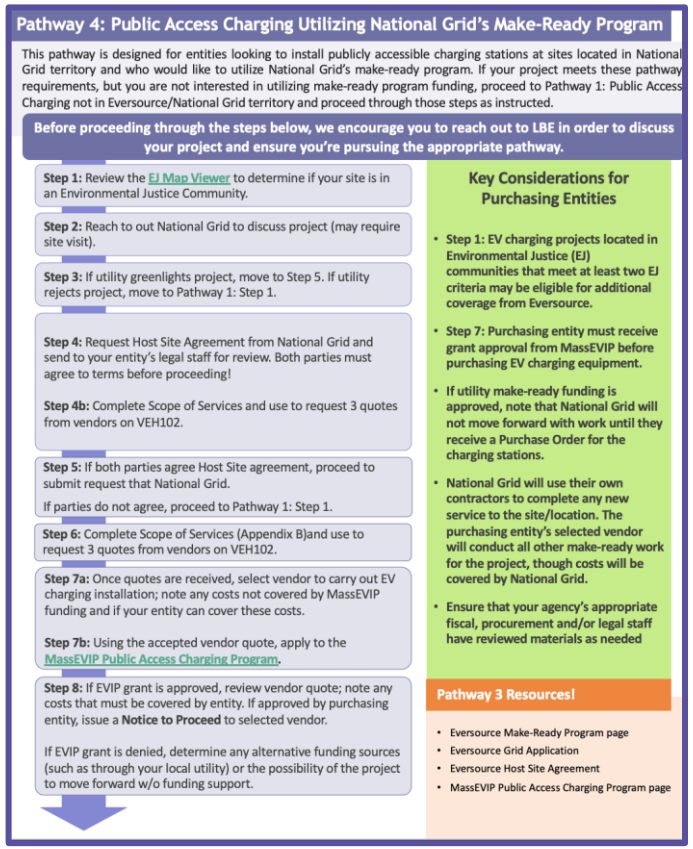
YES — Will the charging stations be for public use?

NO — Do you expect that significant infrastructure work will be needed (e.g., new service, excavation, trenching, etc.)?

YES — Which utility territory is your site located in?

IMPORTANT NOTE: Even if your site is in National Grid or Eversource territory, you are not required to utilize these programs. All MassEVIP programs provide support for infrastructure, installation, and equipment costs (up to $50,000 per street address). For projects that are expected to have limited infrastructure work, Pathways 1 or 2 (depending on the charging use case) may be the better approach.

- **GO TO PATHWAY 1:** Public access charging at sites that are not in Eversource or National Grid
- **GO TO PATHWAY 2:** Workplace/fleet/campus charging that may or may not be in Eversource or National Grid
- **GO TO PATHWAY 3:** Public access charging at sites located in Eversource
- **GO TO PATHWAY 4:** Public access charging at sites located in National Grid



Pathway 4: Public Access Charging Utilizing National Grid's Make-Ready Program

This pathway is designed for entities looking to install publicly accessible charging stations at sites located in National Grid territory and who would like to utilize National Grid's make-ready program. If your project meets these pathway requirements, but you are not interested in utilizing make-ready program funding, proceed to Pathway 1: Public Access Charging not in Eversource/National Grid territory and proceed through those steps as instructed.

Before proceeding through the steps below, we encourage you to reach out to LBE in order to discuss your project and ensure you're pursuing the appropriate pathway.

Step 1: Review the EJ Map Viewer to determine if your site is in an Environmental Justice Community.

Step 2: Reach to out National Grid to discuss project (may require site visit).

Step 3: If utility greenlights project, move to Step 5. If utility rejects project, move to Pathway 1: Step 1.

Step 4: Request Host Site Agreement from National Grid and send to your entity's legal staff for review. Both parties must agree to terms before proceeding!

Step 4b: Complete Scope of Services and use to request 3 quotes from vendors on VEH102.

Step 5: If both parties agree Host Site agreement, proceed to submit request that National Grid.

If parties do not agree, proceed to Pathway 1: Step 1.

Step 6: Complete Scope of Services (Appendix B)and use to request 3 quotes from vendors on VEH102.

Step 7a: Once quotes are received, select vendor to carry out EV charging installation; note any costs not covered by MassEVIP funding and if your entity can cover these costs.

Step 7b: Using the accepted vendor quote, apply to the MassEVIP Public Access Charging Program.

Step 8: If EVIP grant is approved, review vendor quote; note any costs that must be covered by entity. If approved by purchasing entity, issue a **Notice to Proceed** to selected vendor.

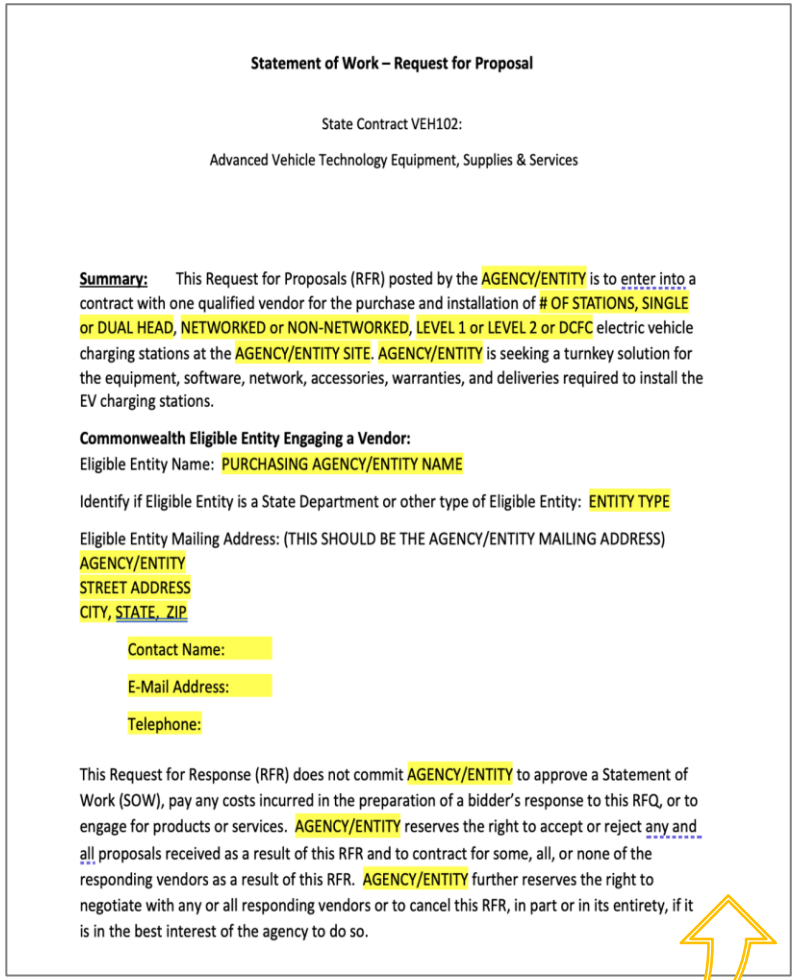
If EVIP grant is denied, determine any alternative funding sources (such as through your local utility) or the possibility of the project to move forward w/o funding support.

Key Considerations for Purchasing Entities

- **Step 1: EV charging projects located in Environmental Justice (EJ) communities that meet at least two EJ criteria may be eligible for additional coverage from Eversource.**
- **Step 7: Purchasing entity must receive grant approval from MassEVIP before purchasing EV charging equipment.**
- **If utility make-ready funding is approved, note that National Grid will not move forward with work until they receive a Purchase Order for the charging stations.**
- **National Grid will use their own contractors to complete any new service to the site/location. The purchasing entity's selected vendor will conduct all other make-ready work for the project, though costs will be covered by National Grid.**
- **Ensure that your agency's appropriate fiscal, procurement and/or legal staff have reviewed materials as needed**

Pathway 3 Resources!

- Eversource Make-Ready Program page
- Eversource Grid Application
- Eversource Host Site Agreement
- MassEVIP Public Access Charging Program page



Statement of Work – Request for Proposal

State Contract VEH102:

Advanced Vehicle Technology Equipment, Supplies & Services

Summary: This Request for Proposals (RFR) posted by the AGENCY/ENTITY is to enter into a contract with one qualified vendor for the purchase and installation of # OF STATIONS, SINGLE or DUAL HEAD, NETWORKED or NON-NETWORKED, LEVEL 1 or LEVEL 2 or DCFC electric vehicle charging stations at the AGENCY/ENTITY SITE. AGENCY/ENTITY is seeking a turnkey solution for the equipment, software, network, accessories, warranties, and deliveries required to install the EV charging stations.

Commonwealth Eligible Entity Engaging a Vendor:
Eligible Entity Name: PURCHASING AGENCY/ENTITY NAME

Identify if Eligible Entity is a State Department or other type of Eligible Entity: ENTITY TYPE

Eligible Entity Mailing Address: (THIS SHOULD BE THE AGENCY/ENTITY MAILING ADDRESS)
AGENCY/ENTITY
STREET ADDRESS
CITY, STATE, ZIP

Contact Name:

E-Mail Address:

Telephone:

This Request for Response (RFR) does not commit AGENCY/ENTITY to approve a Statement of Work (SOW), pay any costs incurred in the preparation of a bidder's response to this RFQ, or to engage for products or services. AGENCY/ENTITY reserves the right to accept or reject any and all proposals received as a result of this RFR and to contract for some, all, or none of the responding vendors as a result of this RFR. AGENCY/ENTITY further reserves the right to negotiate with any or all responding vendors or to cancel this RFR, in part or in its entirety, if it is in the best interest of the agency to do so.

RFP scope of services template

DOER Releases Draft Appliance Standards

- An Act Creating a Next-Generation Roadmap for Massachusetts Climate Policy included new energy and water efficiency standards for a variety of appliances

- In compliance, DOER released proposed updates to existing regulation 225 CMR 9
- The draft amendment includes the following parameters:
  - Manufacturers may only ship products to MA that meet new minimum standards starting in 2022
  - Retailers are prohibited from selling products that fail to meet the standards starting in 2023

Learn More and Submit Comments

- Review the proposed amendment and full list of impacted appliances on the DOER website.
  - Comments may be submitted to DOER.ApplianceStandards@mass.gov, by **5pm, 9/29/21**.
  - Public hearing via Zoom will be held on **September 29th, 2021, 12pm-2pm**. Pre-register here.
- To get future alerts about updates to Appliance Standards, sign up for the DOER Email list named “DOER Appliance Standards.”

2022-2024 Utility Three-Year Planning Update

Fall 2020/Winter 2021
Planning Workshops and Public Comment Sessions

February/March 2021
EEAC develops/votes on plan priorities and recommendations

April 2021
DRAFT Statewide Plan submitted by Mass Save® Program Administrators

Late Spring/Summer 2021
- Draft Plan review
- Additional Public Comment Sessions
- July EEAC Resolution

September/October 2021
Final Statewide Plan submitted to EEAC for review and vote

Oct. 31, 2021
Final Statewide Plan filed with the Department of Public Utilities (DPU)

Nov. 2021 – Jan. 2022
DPU Review

Secretary Theoharides set an emissions reduction goal for utility program administrators:
504,000 MTCO2e for electric
341,000 MTCO2e for gas

*Each goal represents the emissions reductions that are **projected to occur in 2030** as a direct result of investments made by the 2022-2024 plans.*

Draft 2022-2024 Plan can be viewed on the EEAC website: https://ma-eeac.org/plans-updates/

Energy Efficiency Advisory Council
September-October Meeting Schedule

Date	Meeting	Meeting Topic
9/22/2021	Sept. EEAC Meeting	• Updated Plan Data Review
10/13/2021	Oct. EEAC Meeting	• Updated Plan Narrative Review • Continued Data Discussion • Draft Resolution
10/27/2021	Oct. Special Meeting	Final Resolution Vote

Ahead of each meeting, materials can be found at
https://ma-eeac.org/latest-council-meetings-materials/

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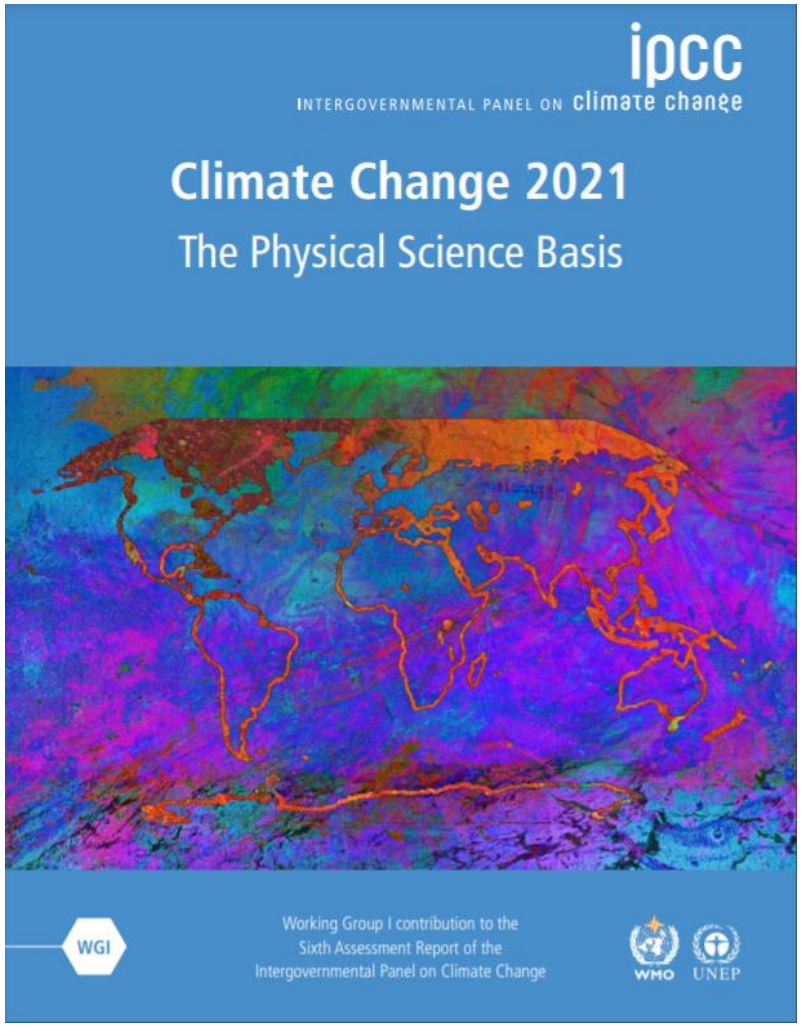
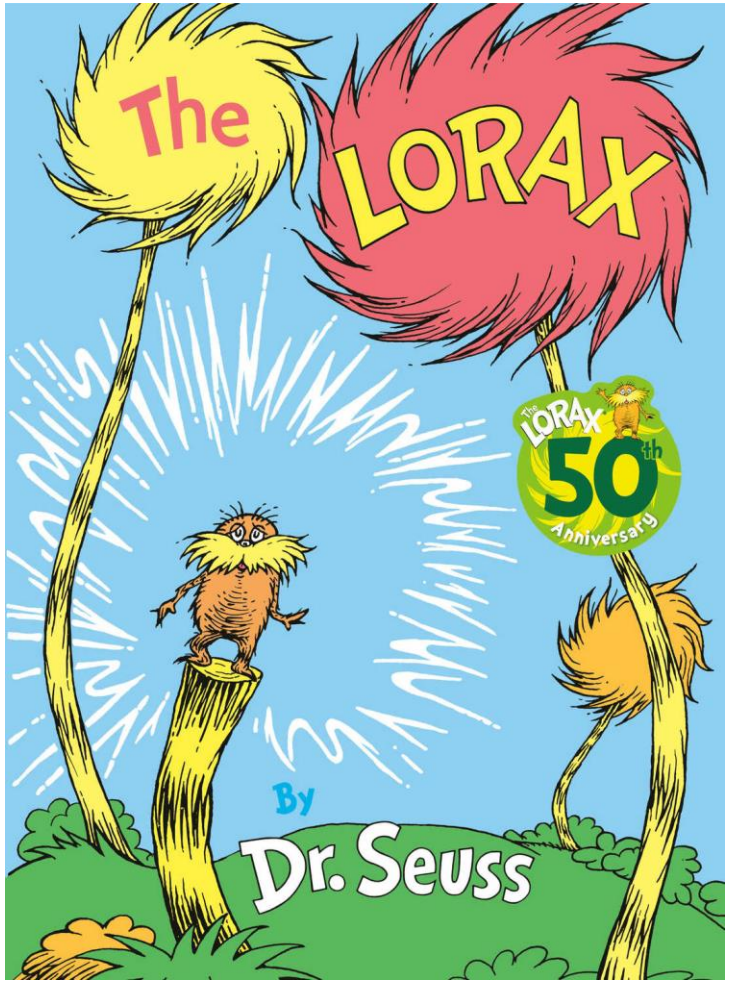
The State of the Global Climate: IPCC Sixth Assessment



and a happy 50th birthday to The Lorax!



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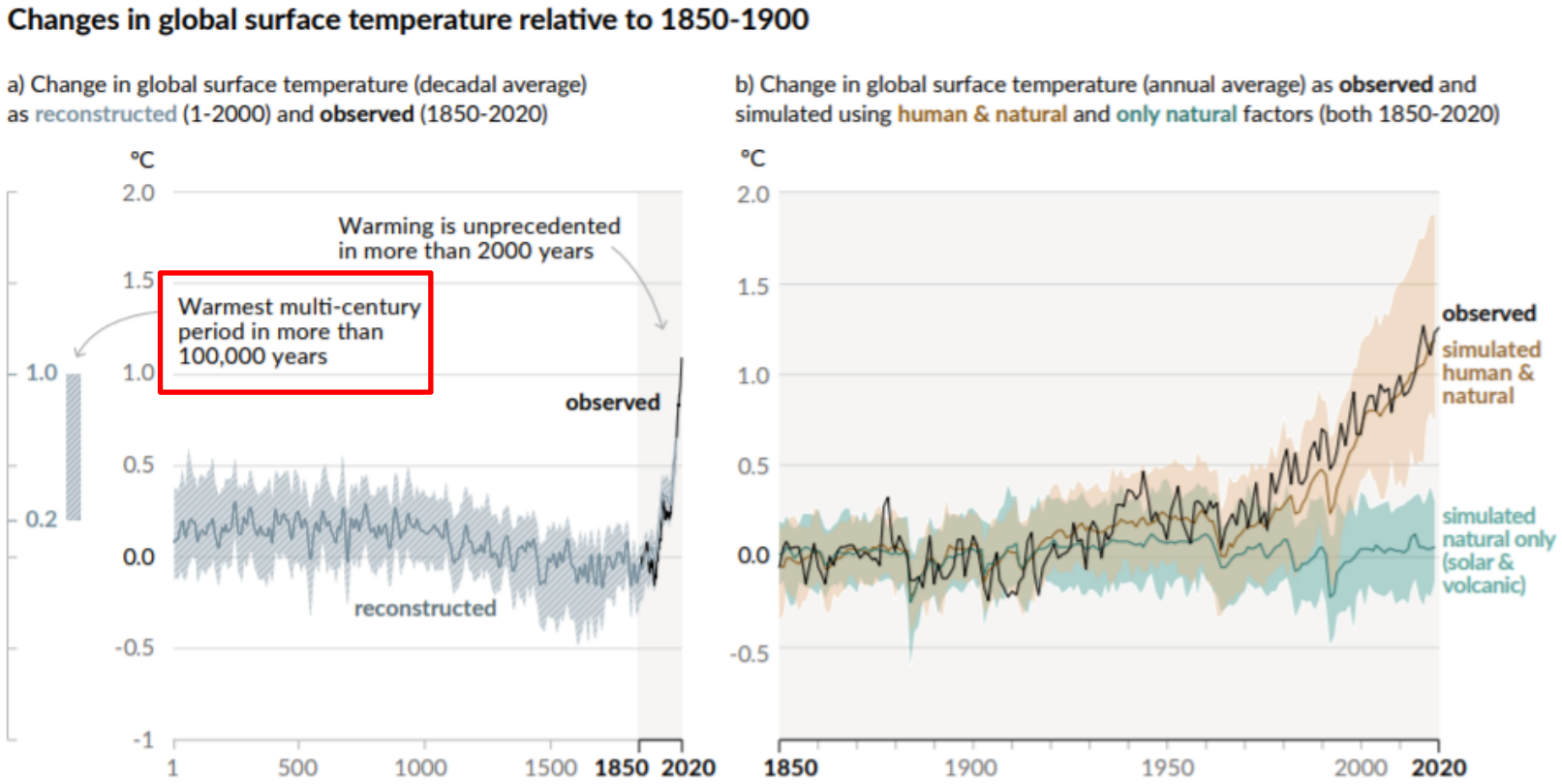
IPCC Sixth Assessment Report: The Physical Science Basis

- The IPCC will release three working group reports before the end of the year:
  - ~~April~~ August 2021 – The Physical Science Basis
  - September 2021 – Mitigation of Climate Change
  - October 2021 – Impacts, Adaptation and Vulnerability
- These reports will inform a Synthesis Report, to be finalized in the first half of 2022
- The Physical Science Basis summary for policy makers is made-up of four sections:
  - Current State of the Climate
  - Possible Climate Futures
  - Climate Information for Risk Assessment and Regional Adaptation
  - Limiting Future Climate Change

The full report, summary, and related documents can be found at:
https://www.ipcc.ch/report/ar6/wg1/

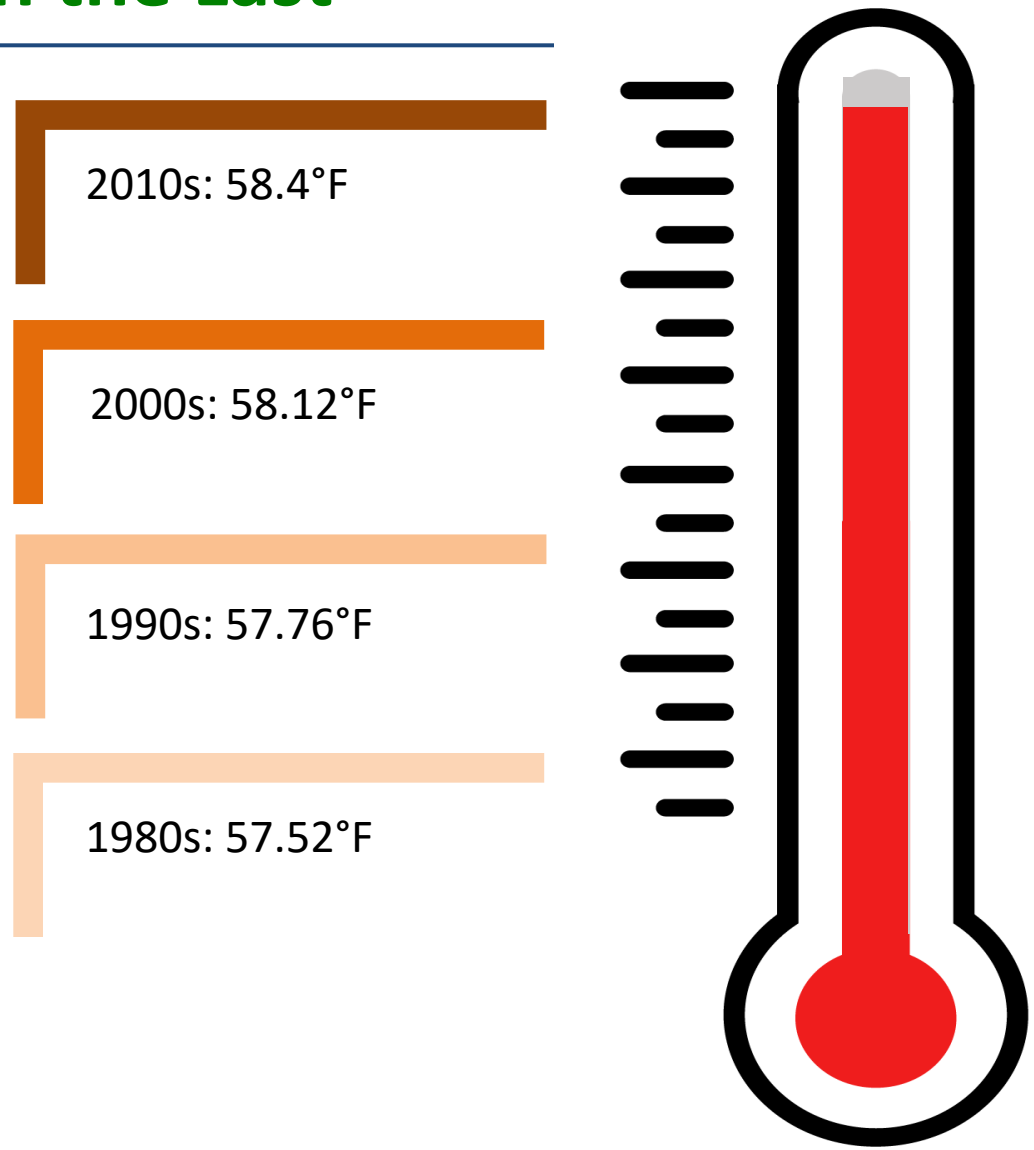
IPCC: Current State of the Climate

- It is **unequivocal** that human influence has warmed the atmosphere, ocean and land
- CO_2 in atmosphere has reached annual average of 410 ppm



IPCC: Each Decade Warmer than the Last

- Each of the last four decades has been **successively warmer** than any decade that preceded it since 1850
- Human influence likely increased global surface temperature by ~1.9°F (1.07°C) over the 1850-1900 average



Source: CurrentResults, APNews

IPCC: Observed Changes in Weather Extremes

- Hot extremes (including heatwaves) have become more frequent and more intense across most land regions since the 1950s.
- Some recent hot extremes observed over the past decade would have been *extremely unlikely* to occur without human influence on the climate system
- The frequency and intensity of heavy precipitation events have increased since the 1950s over mc
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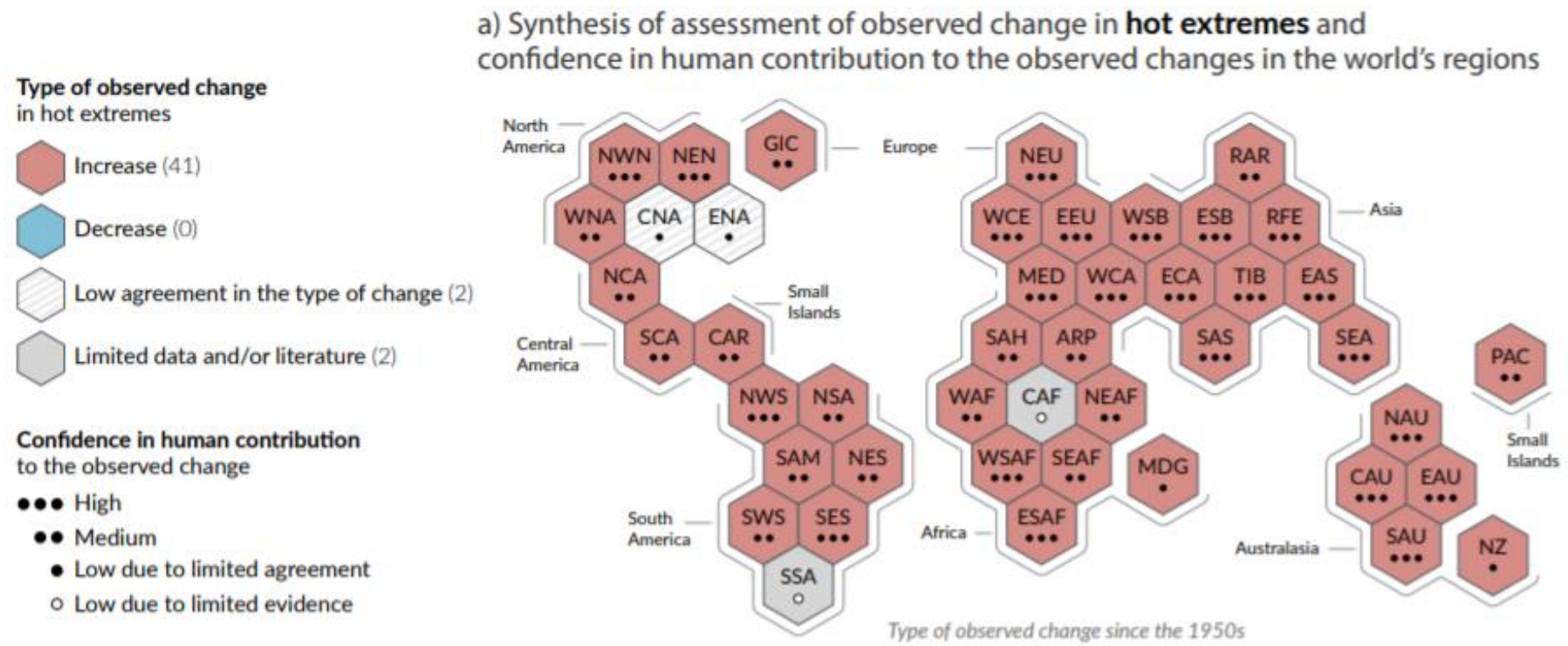
  drc



IPCC: With confidence, we can say human influence has contributed to…

- Reduction in spring snow cover in Northern Hemisphere since 1950 (*very likely*)
- Warming of global upper ocean (0–700 m) since the 1970s (*extremely likely*)
- Acidification of the global surface open ocean (*virtually certain*)
- Reduction of oxygen levels in many upper ocean regions since the mid-20th century (*medium confidence*)
- Increase in global mean sea level by 7.8 in (~0.20m) between 1901 and 2018
- Increase in RATE of sea level rise from 0.05 inches (1.3mm)/yr (1901-1971) to 0.15 inches (3.7mm)/yr (2006-2018) (*very likely*)
- Lengthening of growing season in Northern Hemisphere extratropics by ~two days per decade since 1950s

IPCC: The scale of changes are unprecedented over many thousands of years

Atmospheric CO_2 higher than at any time in last 2 million years

Atmospheric CH_4 and N_2O higher than at any time in at least 800,000 years

Since 1750, increases in CO_2 (47%) and CH_4 (156%) concentrations far exceed the natural multi-millennial changes seen over at least the past 800,000 years

Global surface temperature has increased faster since 1970 than in any other 50-year period over at least the last 2000 years

The global ocean has warmed faster over the past century than since the end of the last deglacial transition (around 11,000 years ago)

Global mean sea level has risen faster since 1900 than over any preceding century in at least the last 3000 years

IPCC: Possible Climate Futures

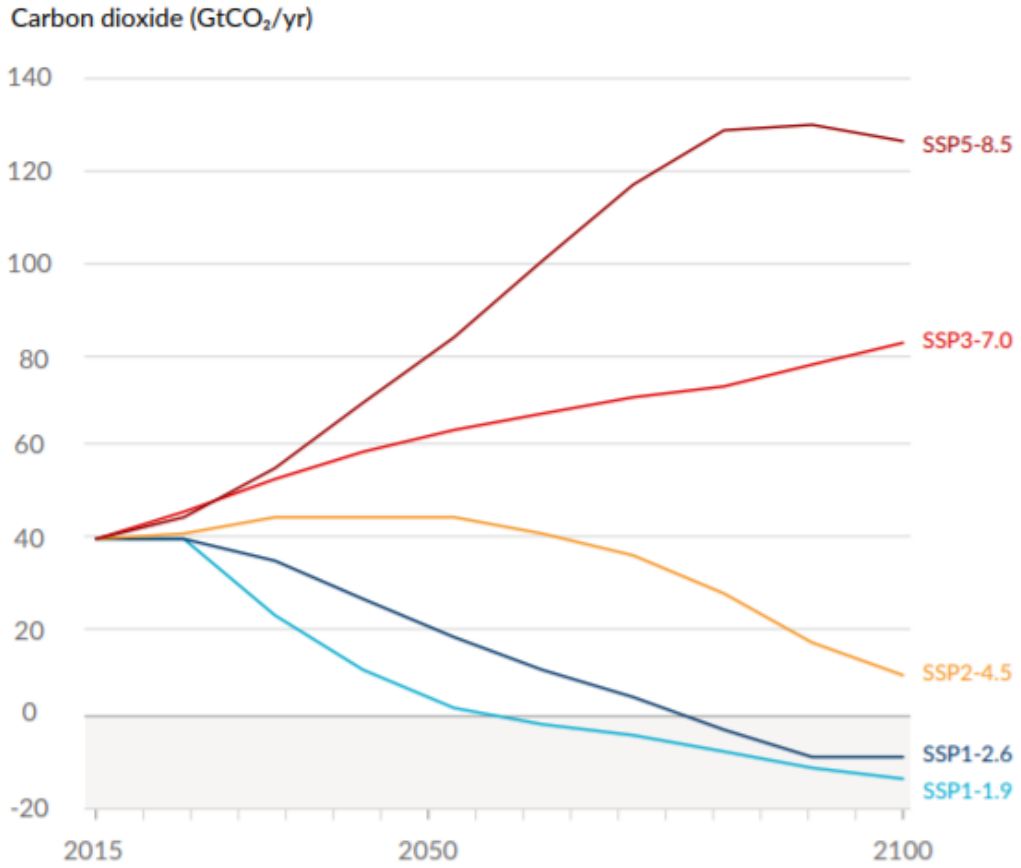
IPCC assessed future climates based on five emissions scenarios:

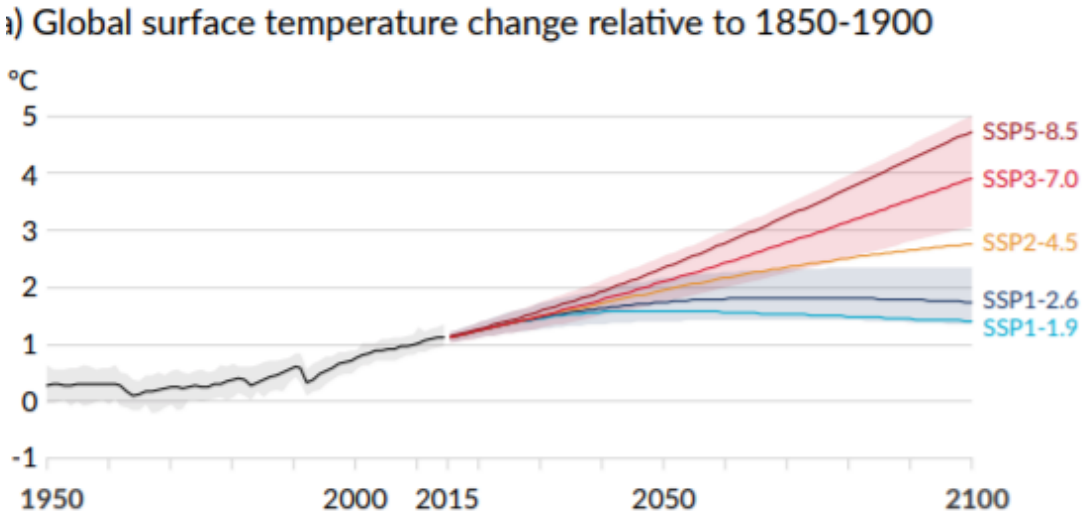
- SSP1-1.9: "Taking the green road" –Rapid drawdown of fossil fuels, increasing energy efficiency, lower resource demands, net zero emissions by mid-century, population peaks at 7 billion
- SSP1-2.6: Slower progress, net-zero emissions after 2050, population peaks at 7 billion
- SSP2-4.5: "Middle of the road" – Aligns with current national pledges, no radical shifts in future global development trends, population peaks at 9.6 billion
- SSP3-7.0: Countries retreat from international cooperation, focus on their own economic goals, population peaks at 12.6 billion. "Not the world we're heading toward right now."
- SSP5-8.5: Global economic growth across the board fueled by burning coal, oil, natural gas, population peaks at 7 billion

Source: Vox

IPCC: Possible Climate Futures

- In all scenarios, temperature will continue to increase until at least the mid-century
- Warming of 3.6°F (2°C) will be exceeded during the 21st century **unless** deep reductions in greenhouse gas emissions occur in the coming decades





5.9-10.3°F*
(3.3-5.7°C)

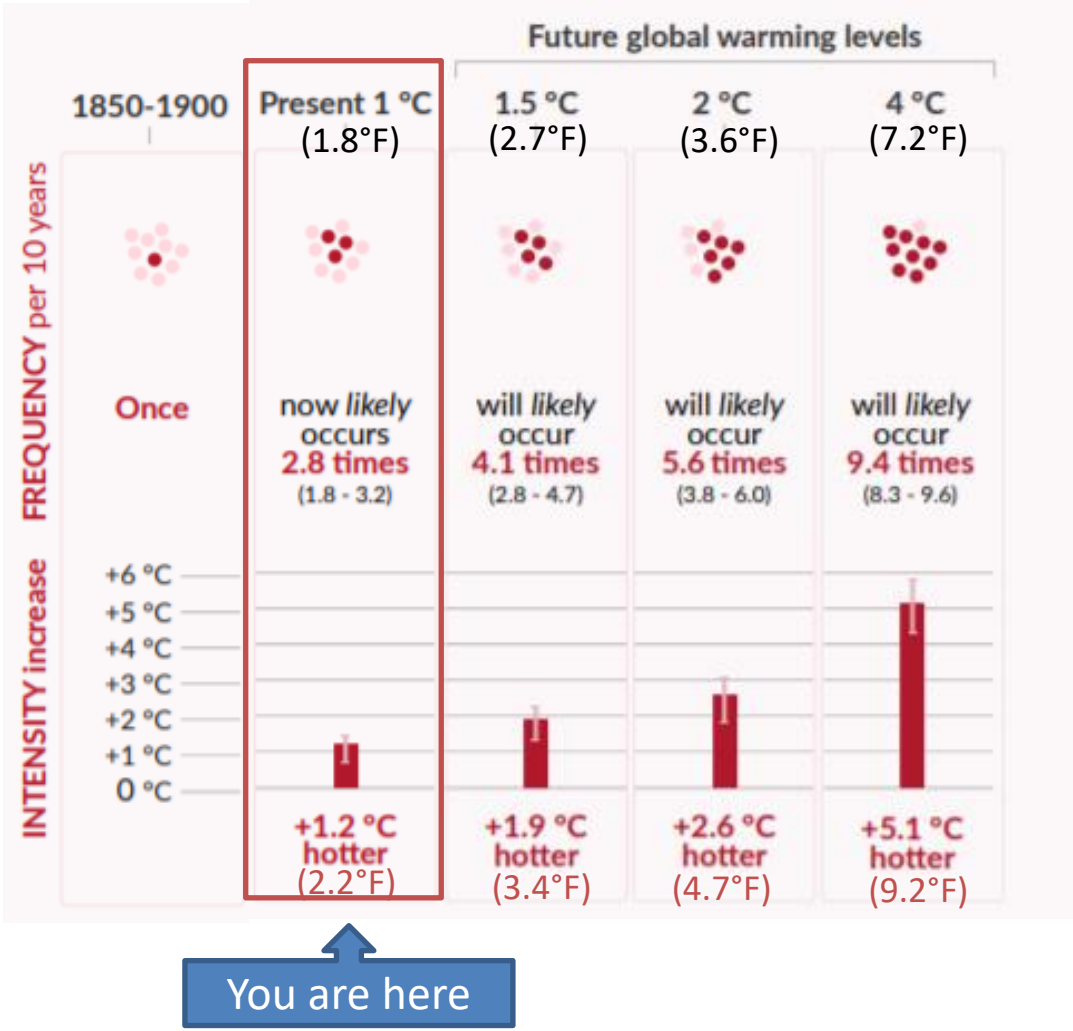
3.8-6.3°F*
(2.1-3.5°C)

1.8-3.24°F*
(1-1.8°C)

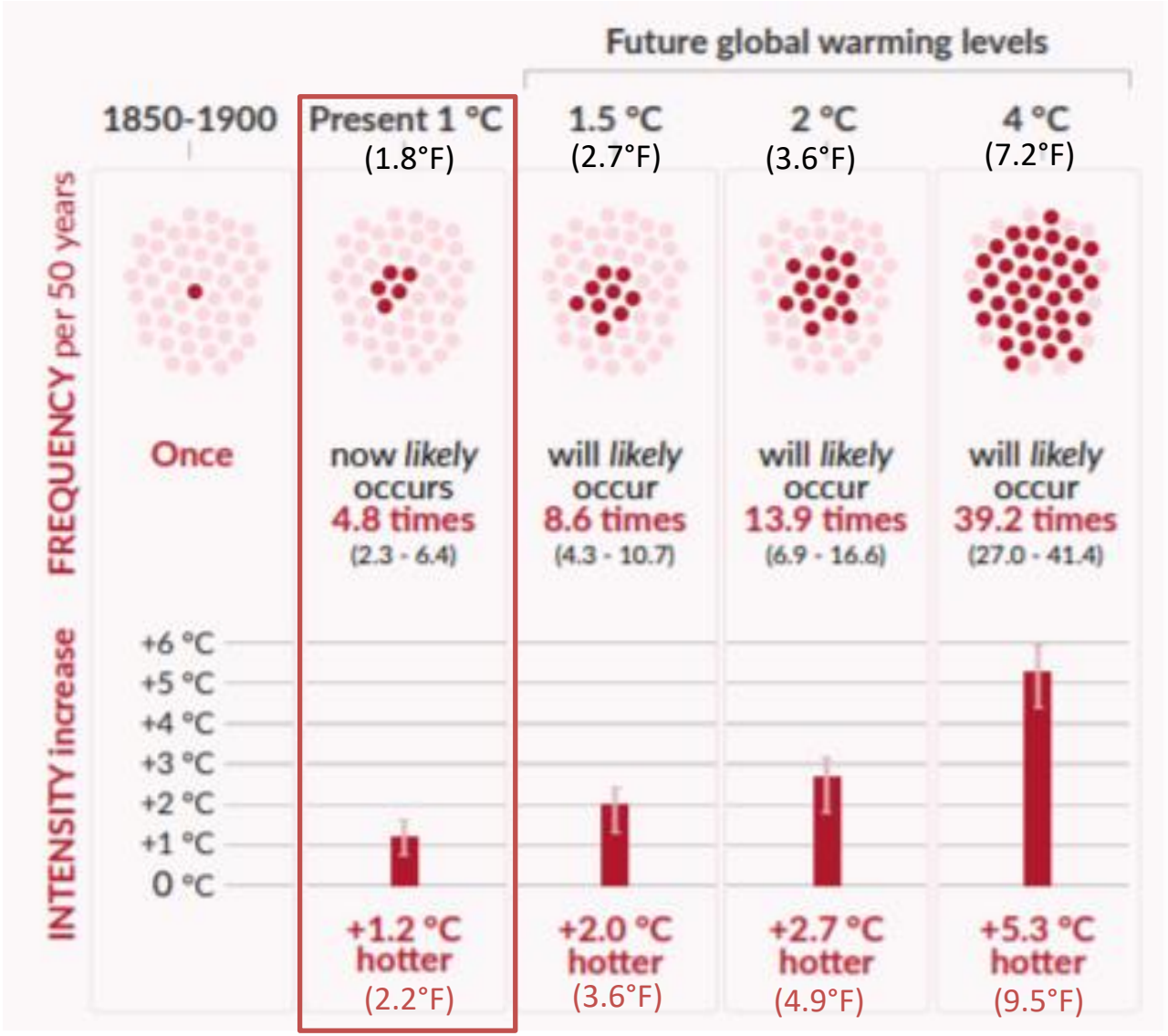
**Estimated average global surface temp in 2080-2100 period, over 1850-1900 average*

IPCC: Extreme Weather Events: One in Ten-Year Heat Events

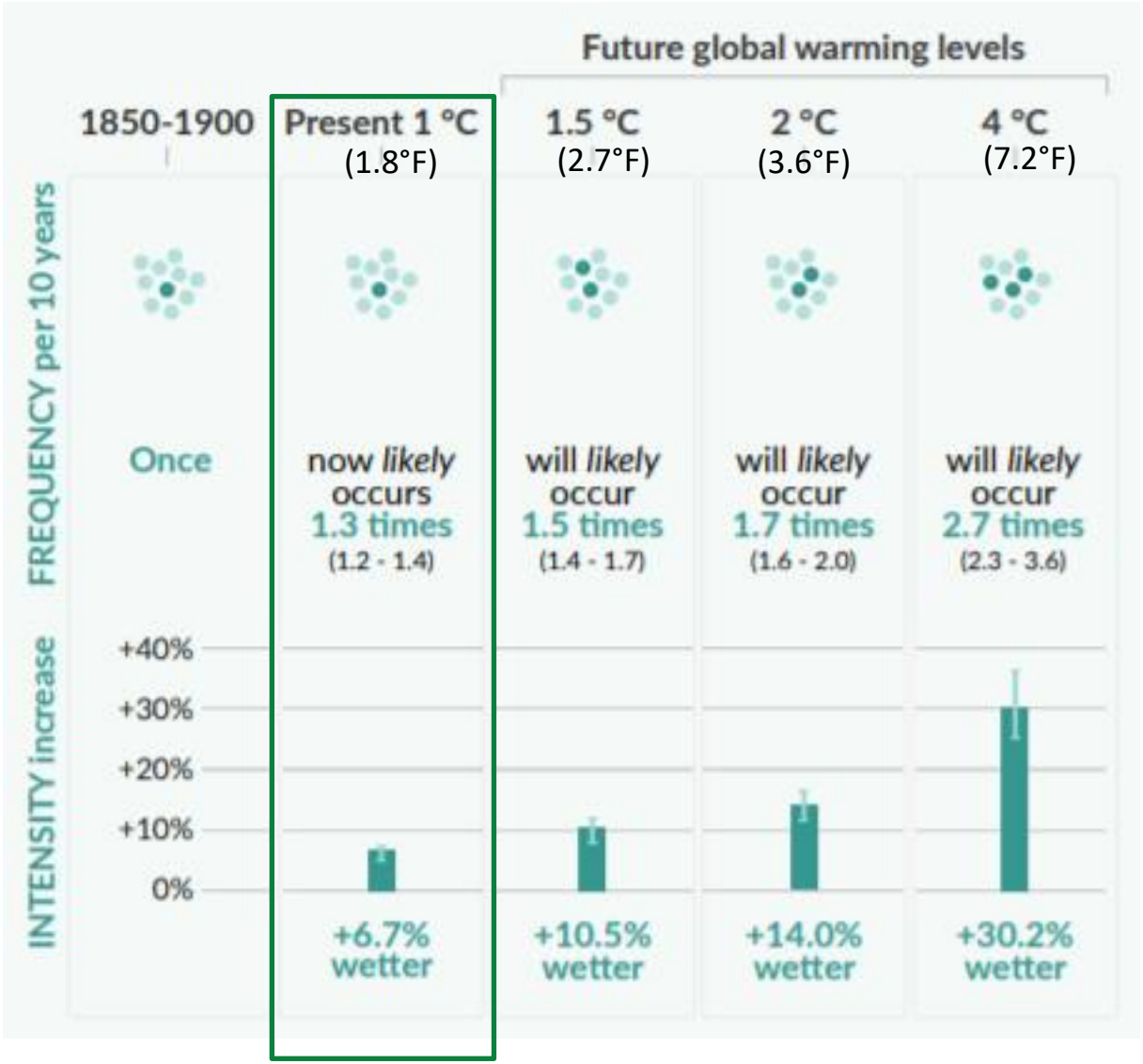
- A one-in-10-year extreme heat event now occurs 2.8 times in 10 years
- These events will take place 4.1-9.4 times every 10 years, depending on future warming



IPCC: Extreme Weather Events: One in 50-Year Heat Events

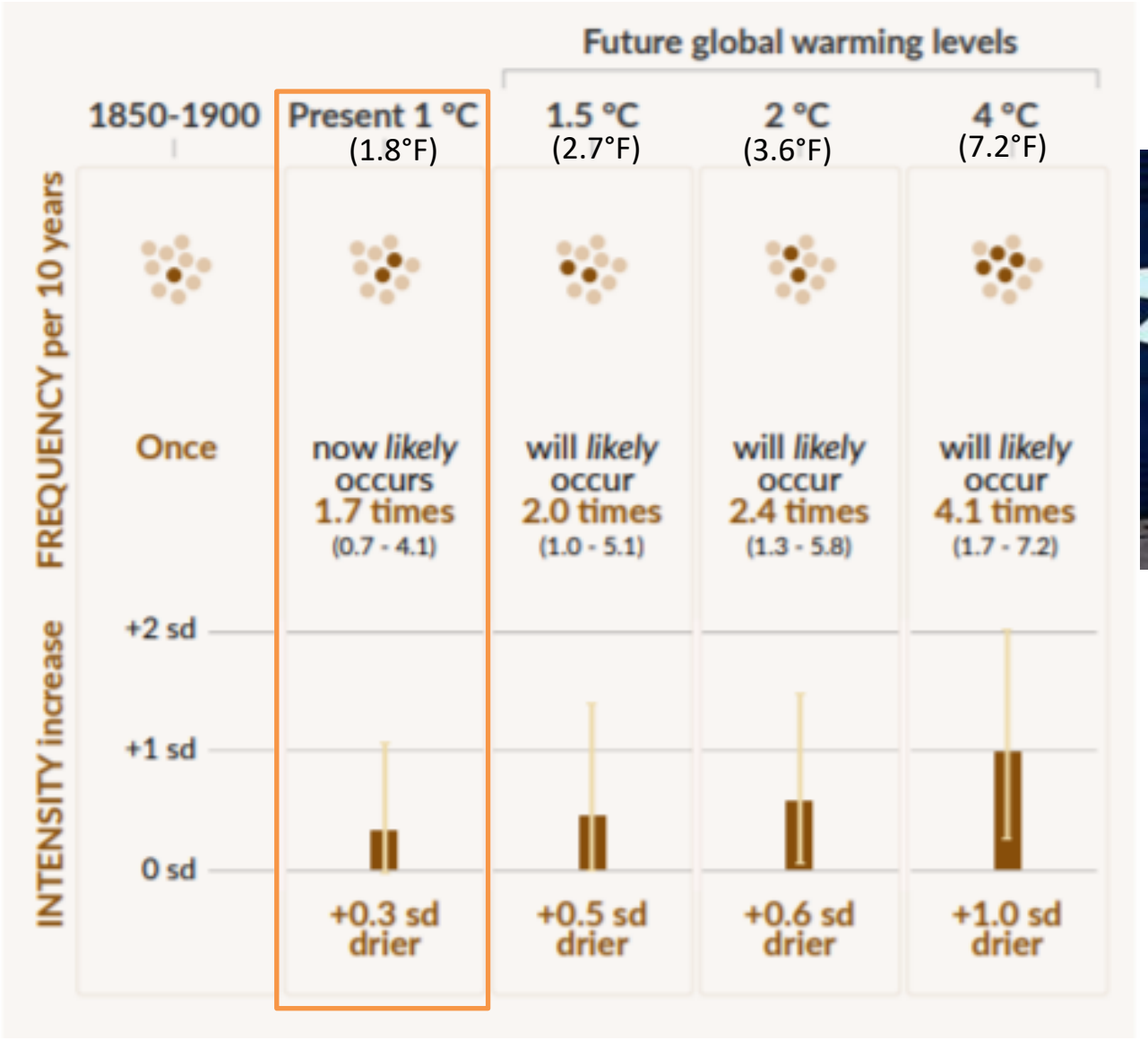


IPCC: Extreme Weather Events: One in 10-Year Heavy Rain Events*



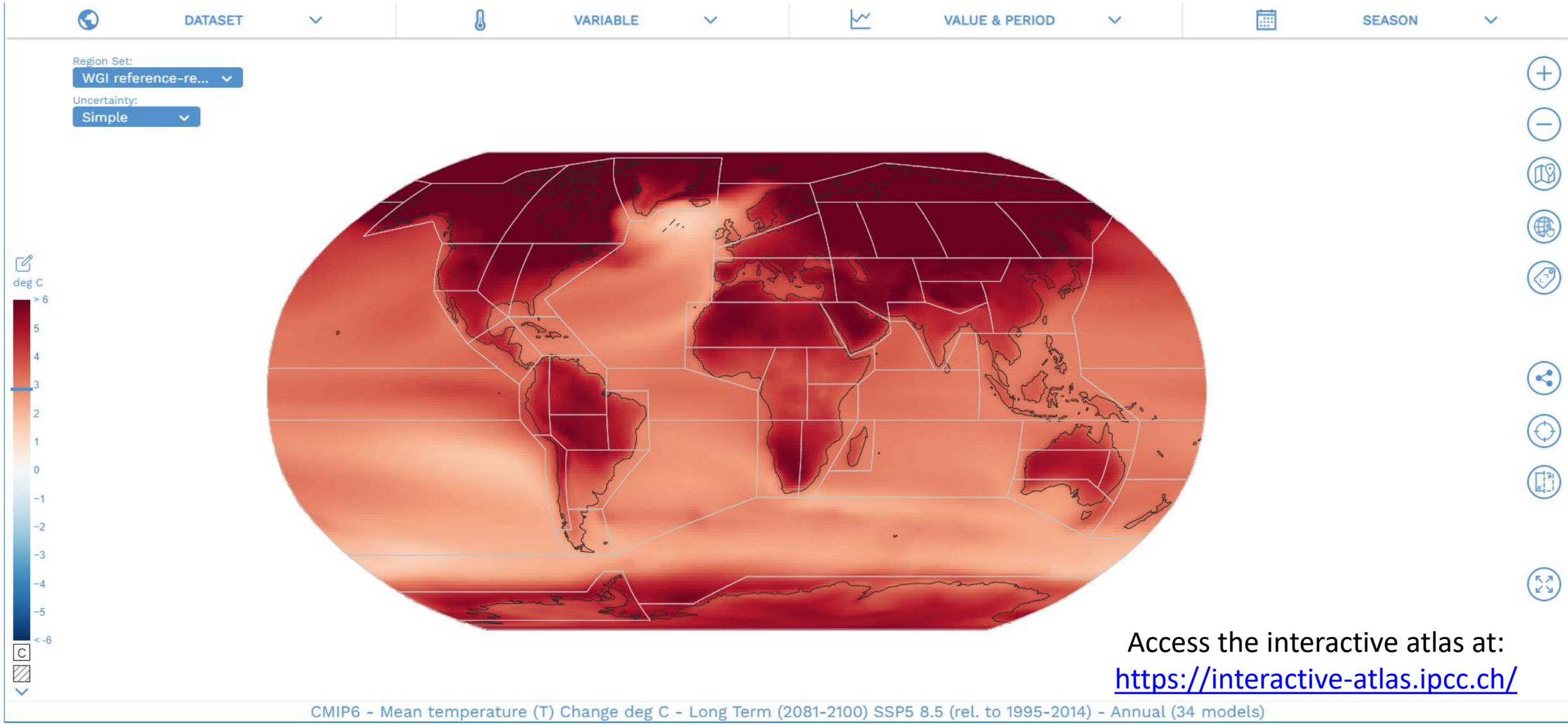
*One-day precipitation events

IPCC: Extreme Weather Events: One in 10-Year Droughts*



**Agricultural and ecological drought events in average across drying regions*

IPCC: WGI Interactive Atlas

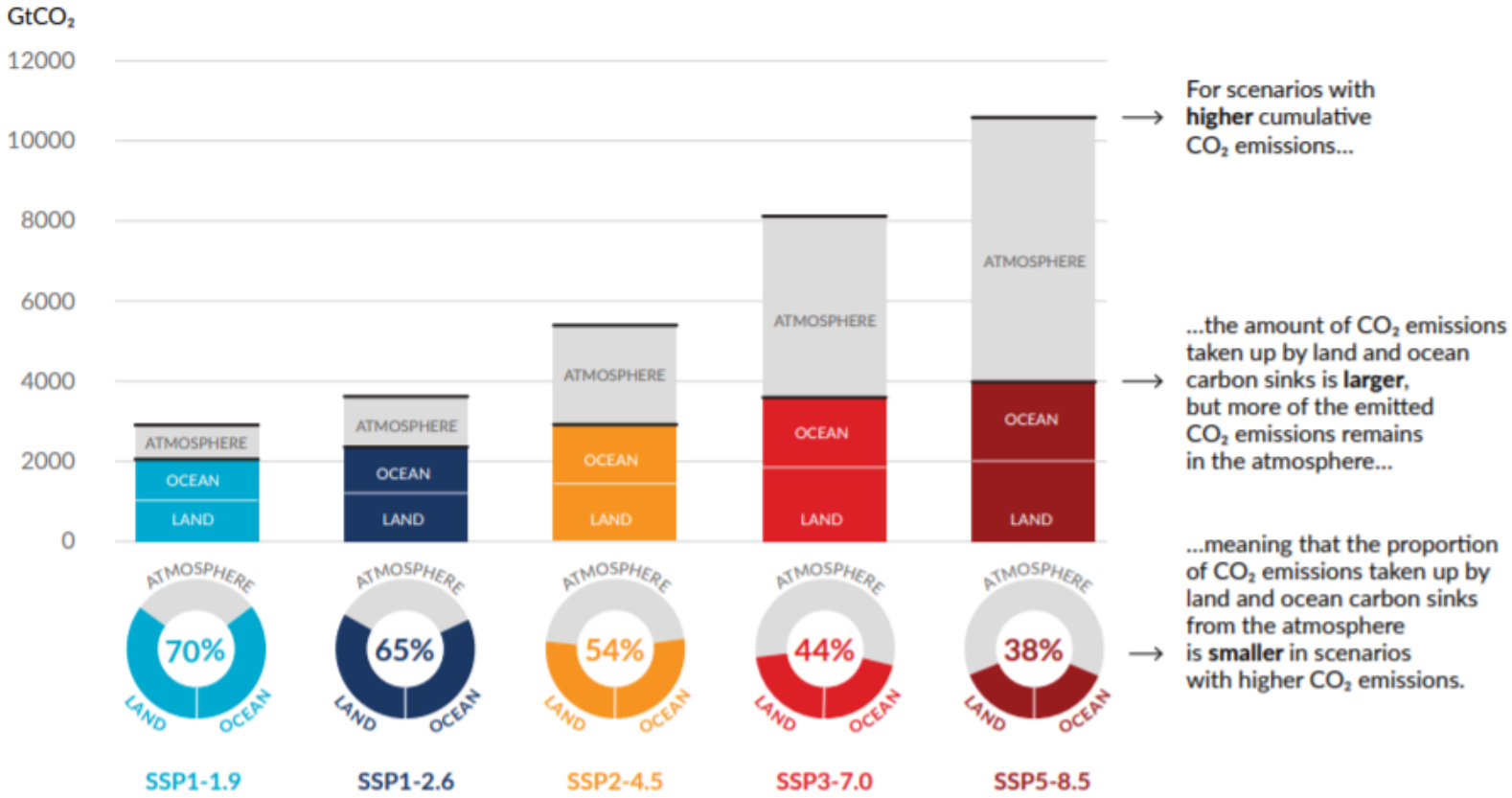


Access the interactive atlas at:
https://interactive-atlas.ipcc.ch/

IPCC: Carbon Sinks Lose Effectiveness Under High Emissions Scenarios

The proportion of CO_2 emissions taken up by land and ocean carbon sinks is smaller in scenarios with higher cumulative CO_2 emissions

Total cumulative CO_2 emissions **taken up by land and oceans** (colours) and remaining in the atmosphere (grey) under the five illustrative scenarios from 1850 to 2100



IPCC: Remaining Global Carbon Budget

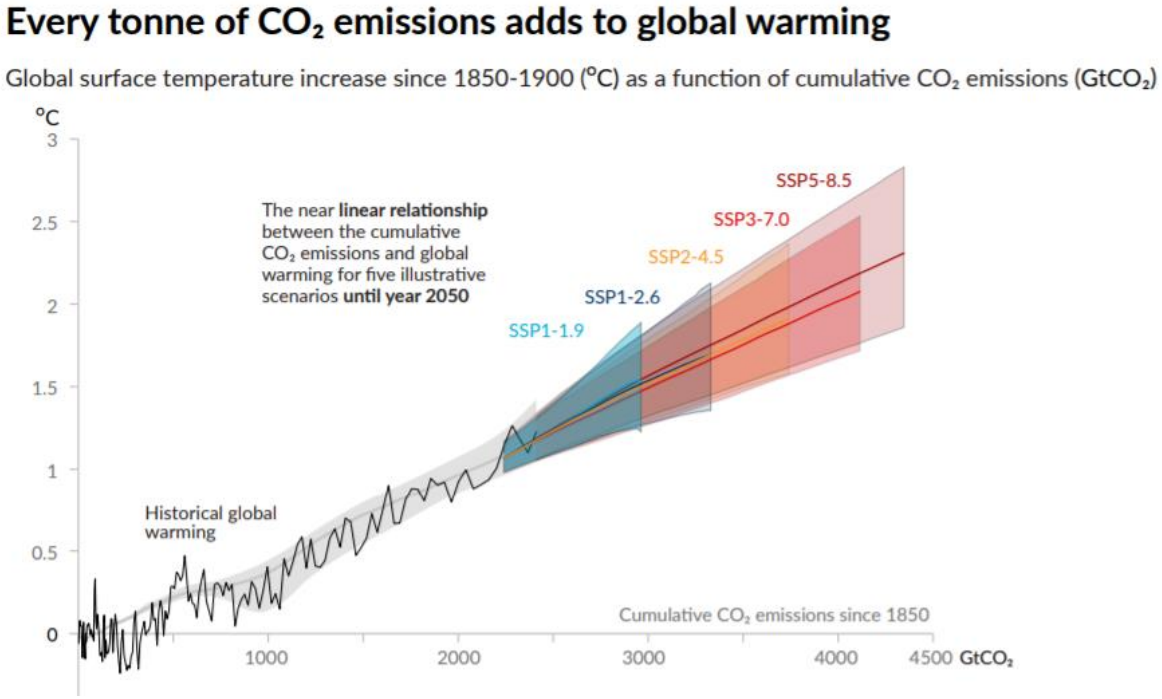
Global warming between 1850–1900 and 2010–2019 *(°C)*	Historical cumulative CO_2 emissions from 1850 to 2019 *($GtCO_2$)*
1.07 (0.8–1.3; *likely* range)	2390 (± 240; *likely* range)

Approximate global warming relative to 1850–1900 until temperature limit *(°C)**(1)	Additional global warming relative to 2010–2019 until temperature limit *(°C)*	Estimated remaining carbon budgets from the beginning of 2020 *($GtCO_2$)* — *Likelihood of limiting global warming to temperature limit*(2)*					Variations in reductions in non-CO_2 emissions*(3)
		17%	*33%*	*50%*	*67%*	*83%*	
1.5	0.43	900	650	500	400	300	Higher or lower reductions in accompanying non-CO_2 emissions can increase or decrease the values on the left by 220 $GtCO_2$ or more
1.7	0.63	1450	1050	850	700	550	
2.0	0.93	2300	1700	1350	1150	900	

43.1 billion tons of CO_2 was emitted in 2019. If we maintain that level every year, we will pass the lowest estimated carbon budget (300 $GtCO_2$) within 7 years.

IPCC: Limiting Future Climate Change

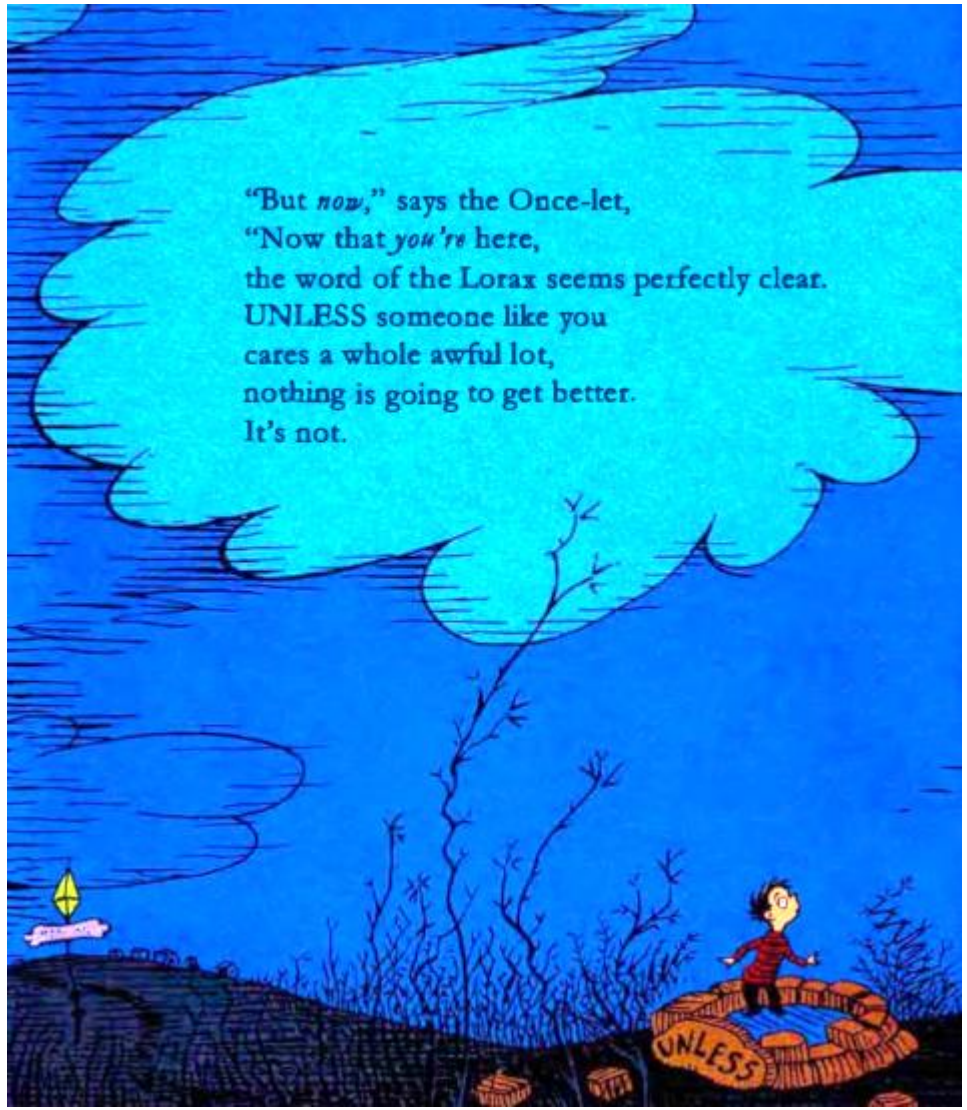
- Each 1000 $GtCO_2$ increase is likely to increase global surface temperature by 0.49°F (*0.27°C*) to 1.13°F (*0.63°C*)
- **Achieving global net zero CO_2 emissions is a requirement for stabilizing CO_2-induced global surface temperature increases**, with anthropogenic CO_2 emissions balanced by anthropogenic removals of CO_2



IPCC: Unless…

- **Limiting GHG emissions** will lead to **discernible effects** on greenhouse gas and aerosol concentrations, and air quality, relative to high and very high GHG emissions scenarios
- **Discernible differences in trends** of global surface temperature would **begin to emerge from natural variability within around 20 years**
- By the end of the century, scenarios with **very low and low GHG emissions would strongly limit the change of several climate impact drivers**, and **the number of regions where such exceedances occur**

In short, 1.5C is better than 2C is better than 3C is better than 4C…



Creating a Clean, Affordable and Resilient Energy Future for the Commonwealth

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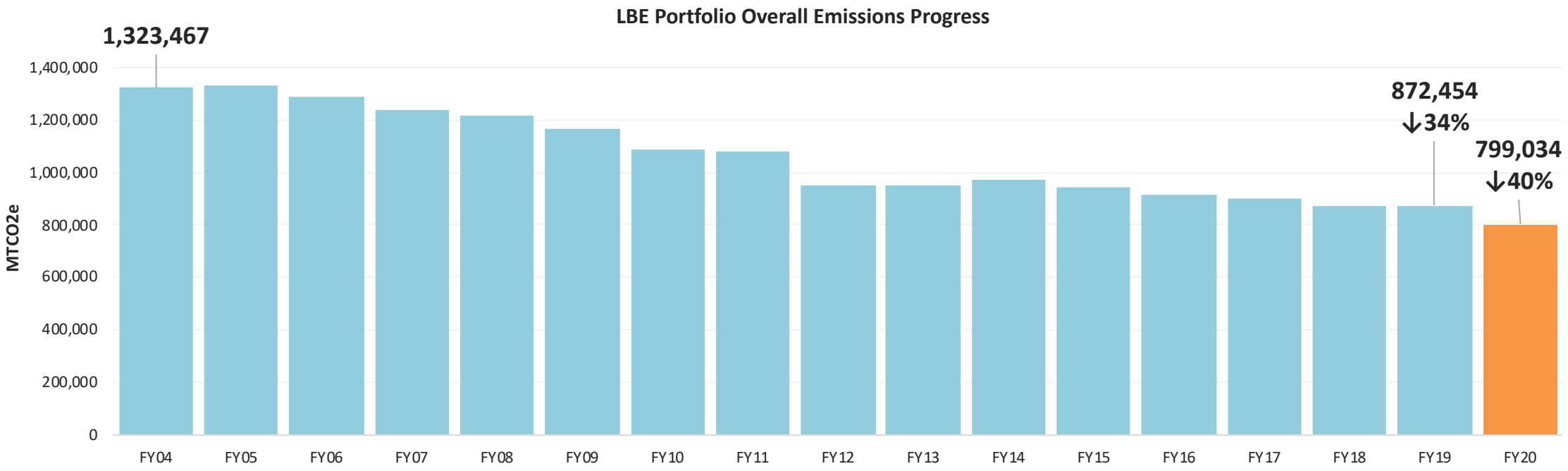
State of the LBE Portfolio

LBE Progress: Overall Emissions

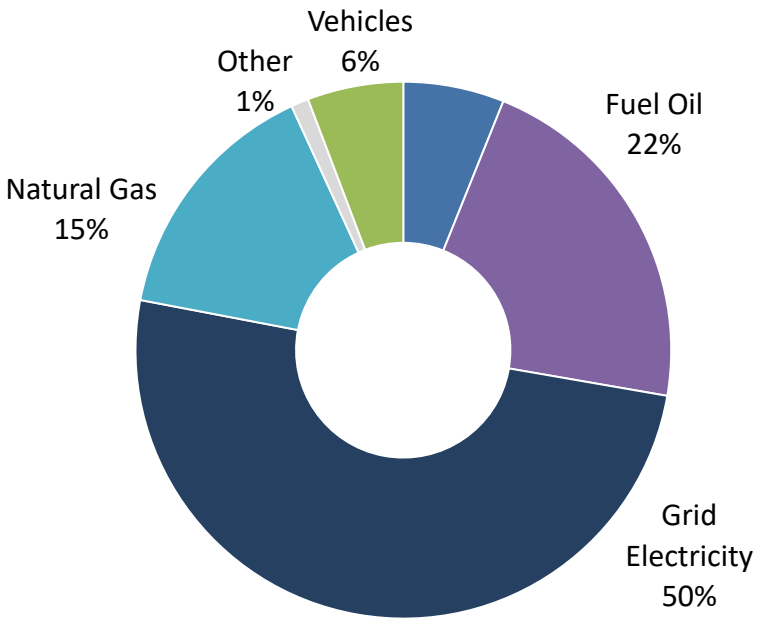
- In FY20, overall portfolio emissions decreased by 524,000 metric tonnes of CO2e over the FY04 baseline, equivalent to a 40 percent reduction
- Roughly an 8% change over FY19, resulting from portfolio efforts & COVID-related closures



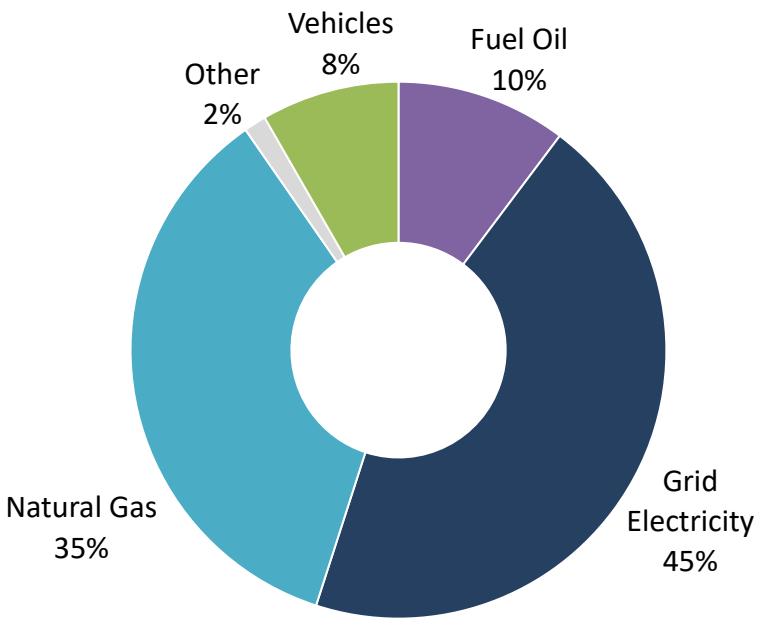
*FY20 data reflects impacts from COVID-related closures in March – June 2020.

LBE Progress: Emissions Changes Over Time

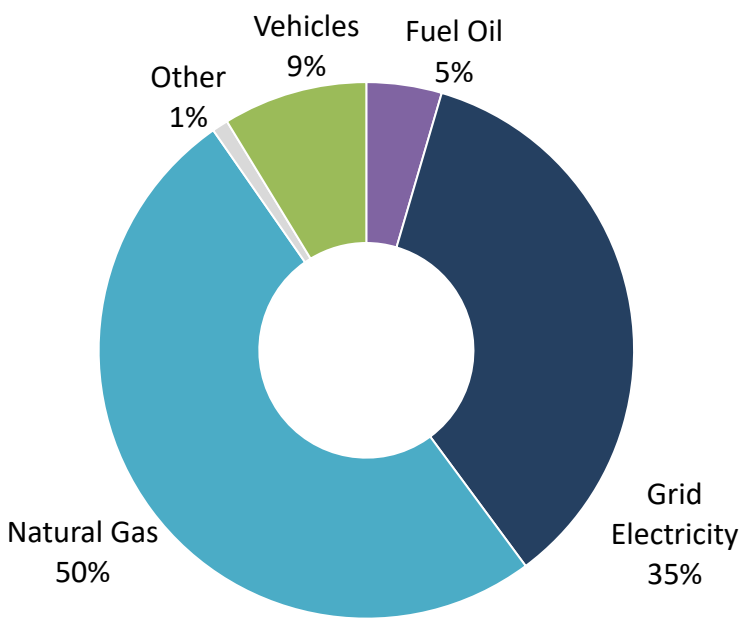
Emissions by Fuel: FY04



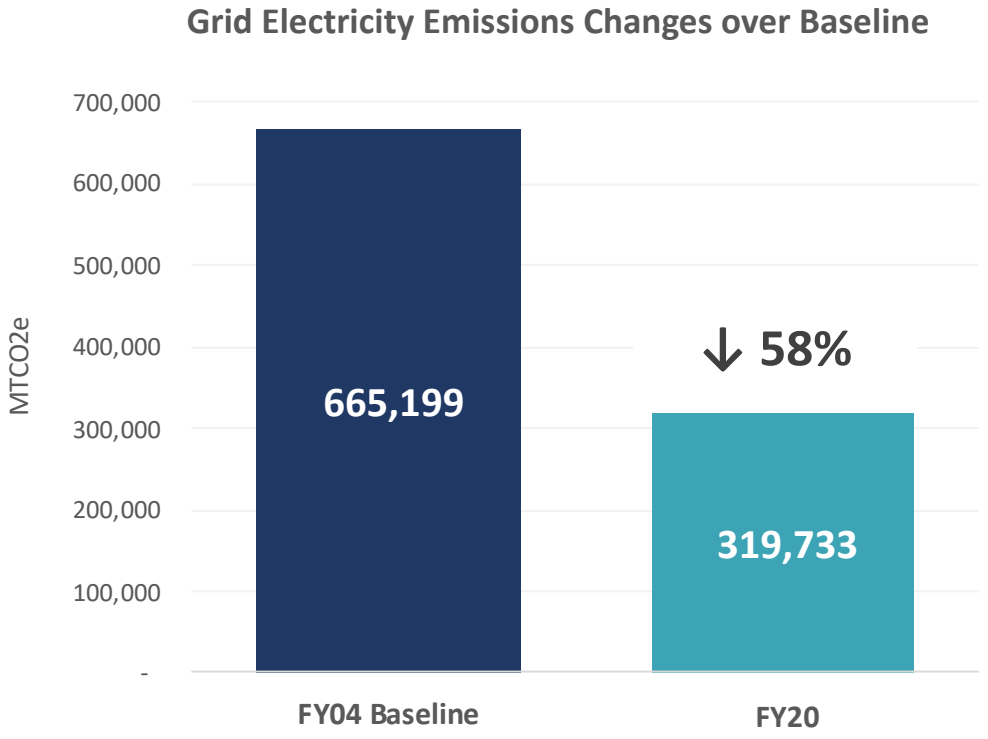
Emissions by Fuel: FY12

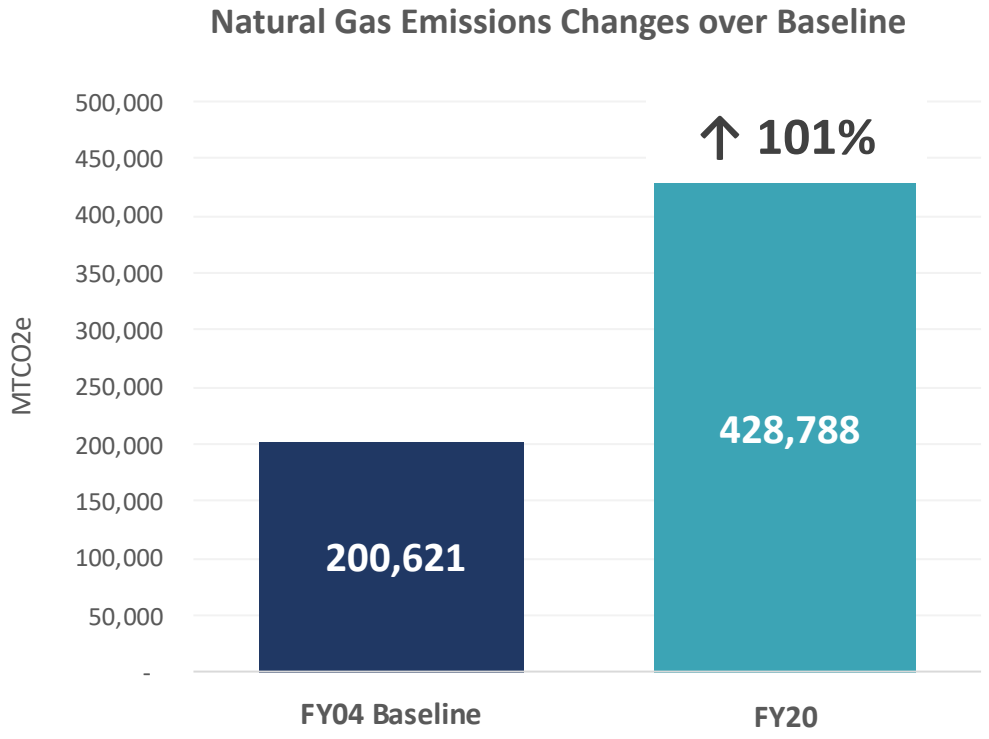


Emissions by Fuel: FY20



LBE Progress: Change in Grid vs. Natural Gas Emissions



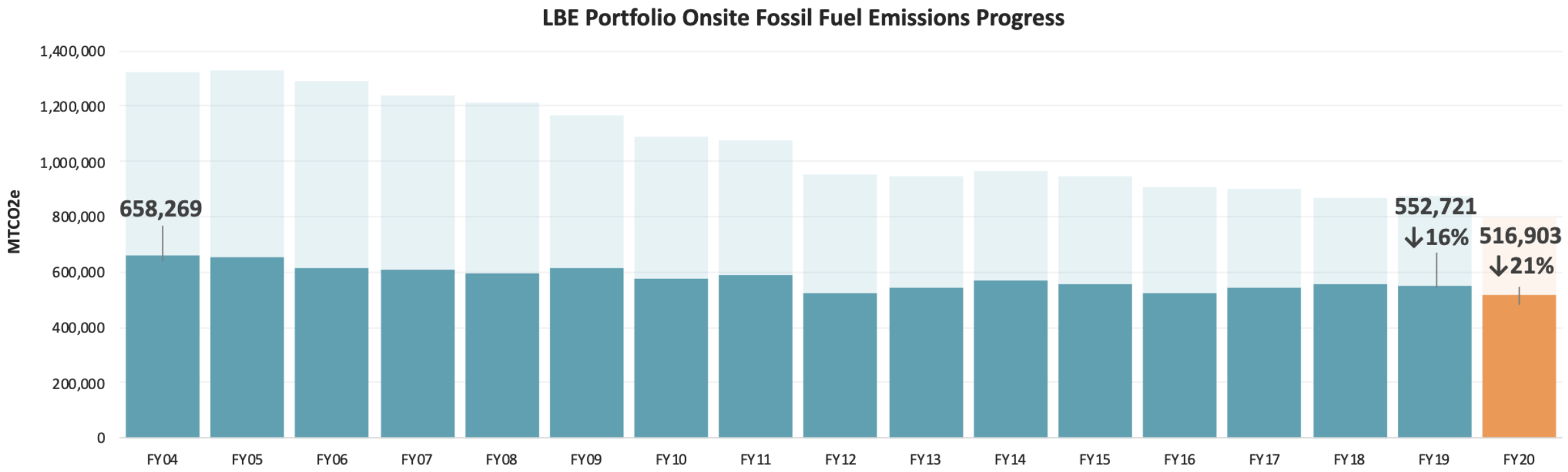


Since FY04, grid electricity emissions have been cut in half, shifting the relative contribution to overall portfolio emissions from 50% to 35%.

Since FY04, the natural gas emissions have more than doubled, shifting the relative contribution to overall portfolio emissions from 15% to 50%.

LBE Progress: Onsite Fossil Fuel Emissions

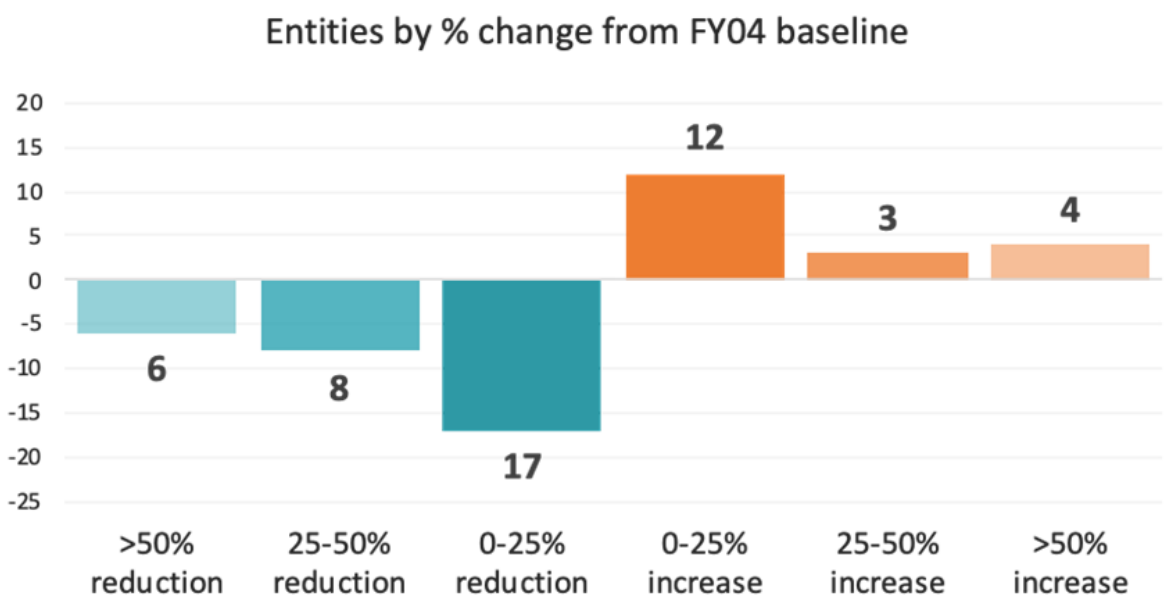
- In FY20, portfolio onsite fossil fuel emissions decreased by 141,000 metric tonnes of CO2e over the FY04 baseline, equivalent to a 21 percent reduction
- Roughly a 6% change over FY19, resulting from portfolio efforts & COVID-related closures



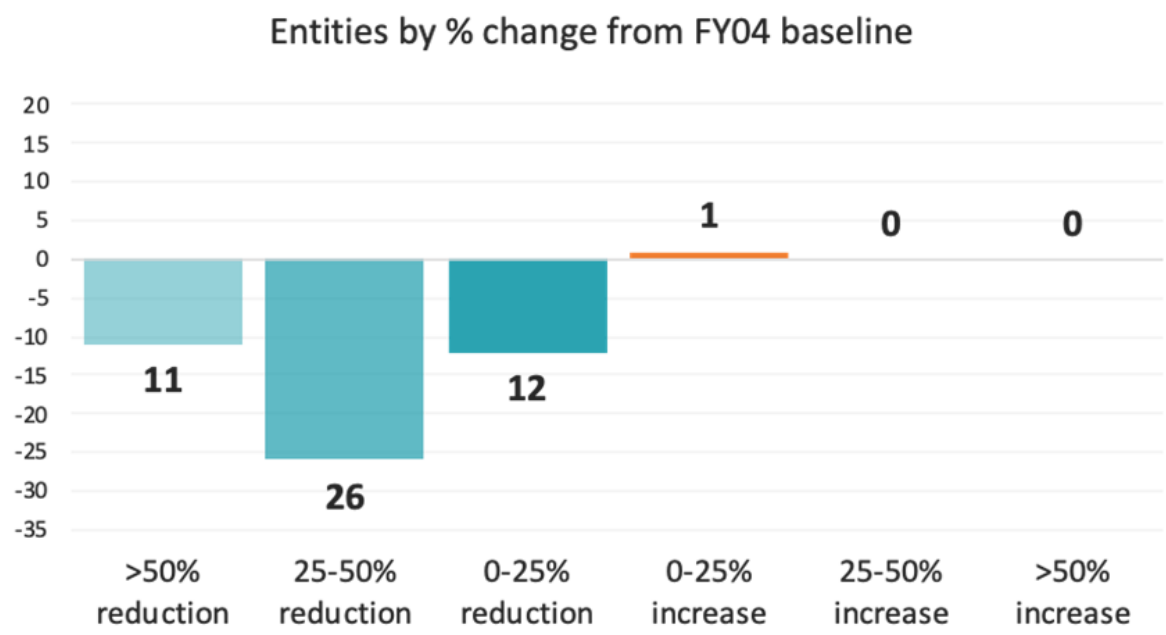
*FY20 data reflects impacts from COVID-related closures in March – June 2020.

LBE Progress: Fossil Fuel Emissions Trends (% change)

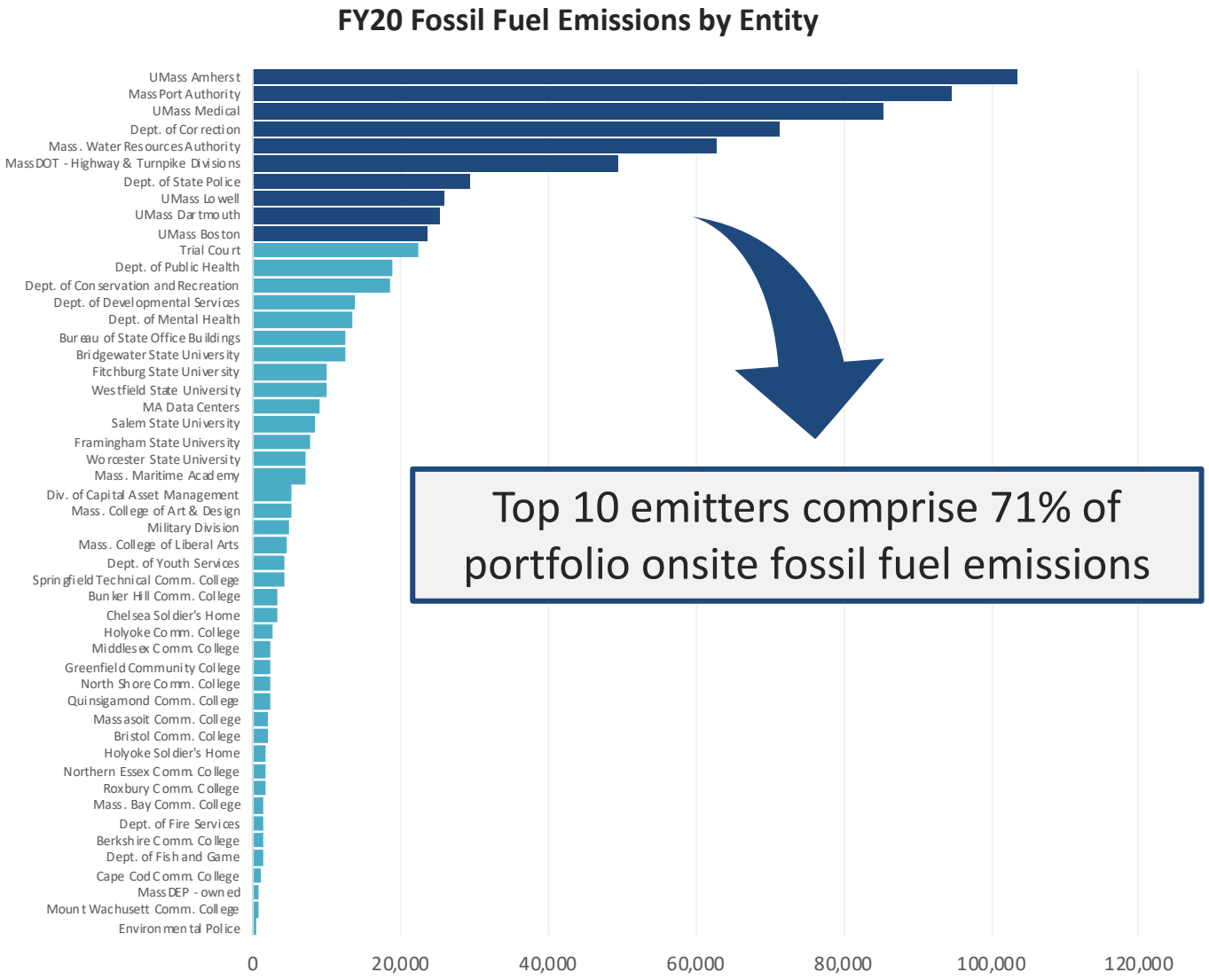
FY19



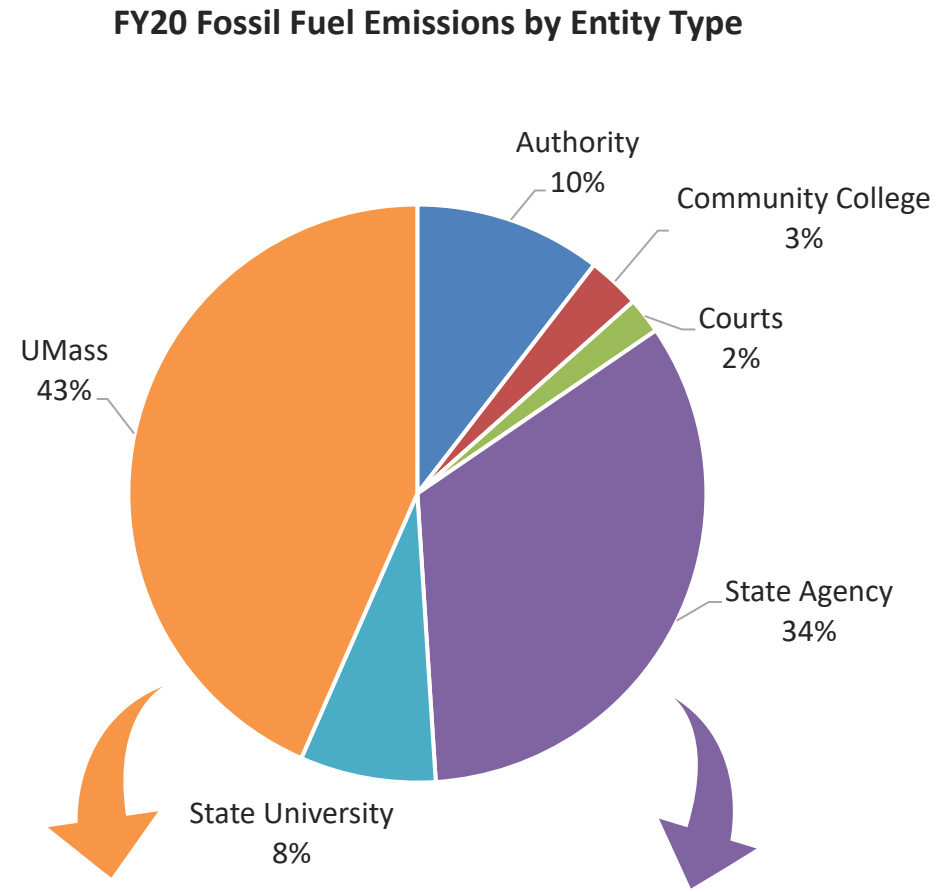
FY20



FY20: Fossil Fuel Emissions by Entity



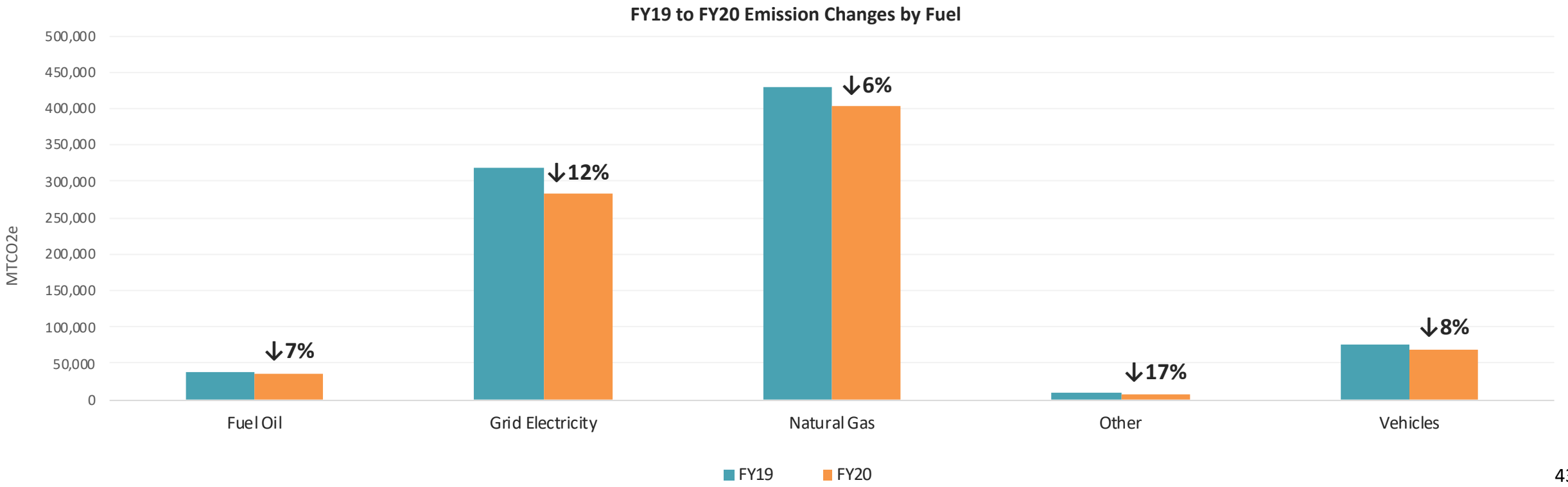
Top 10 emitters comprise 71% of portfolio onsite fossil fuel emissions



UMass System and Executive Branch comprise 76% of portfolio emissions

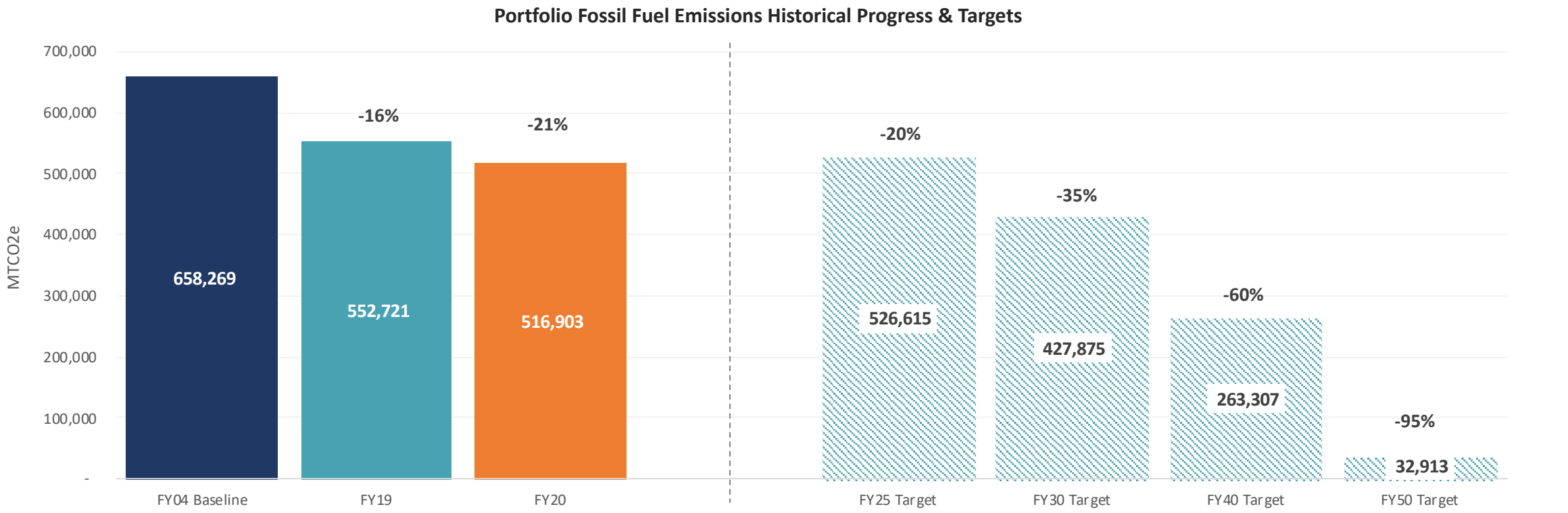
LBE Progress: FY19 vs. FY20 Emissions Comparison

- COVID-related closures impacted roughly 3 ½ months of FY20 operations
- Grid electricity saw the most significant year-over-year decline (12%)
- Natural gas saw the most moderate decline (6%)



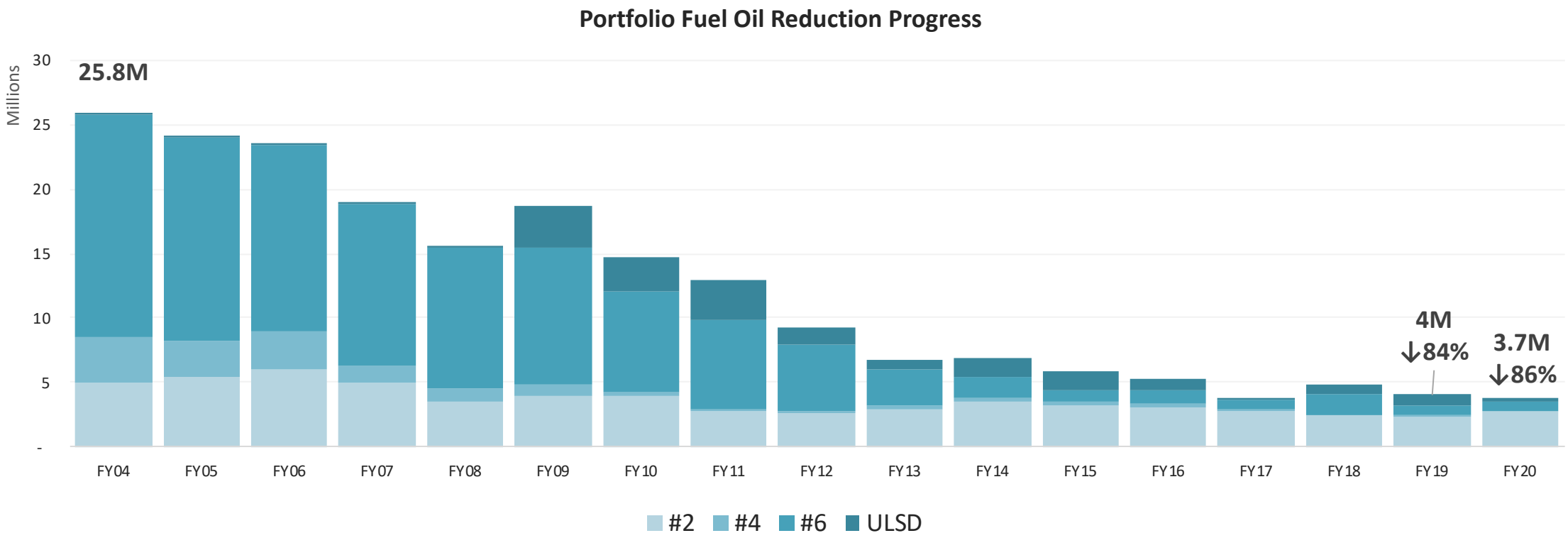
LBE Progress: Achieving Onsite Fossil Fuel Targets

Portfolio must reduce fossil fuel emissions ~5% (26,000 MTCO2e) by 2025, from FY19 benchmark



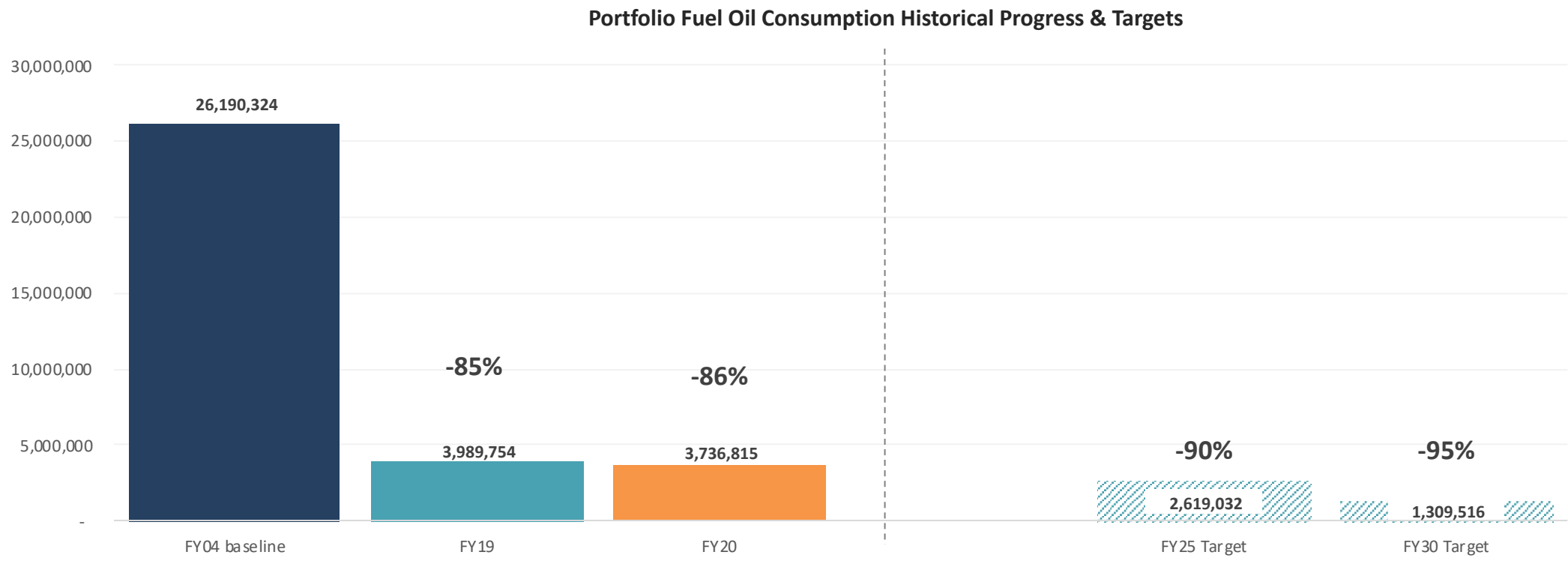
LBE Progress: Fuel Oil Reduction

- In FY20, fuel oil consumption decreased by 22M gallons over the FY04 baseline, an 86 percent reduction
- Have nearly eliminated fuel oils #4 and #6 from portfolio as of FY21



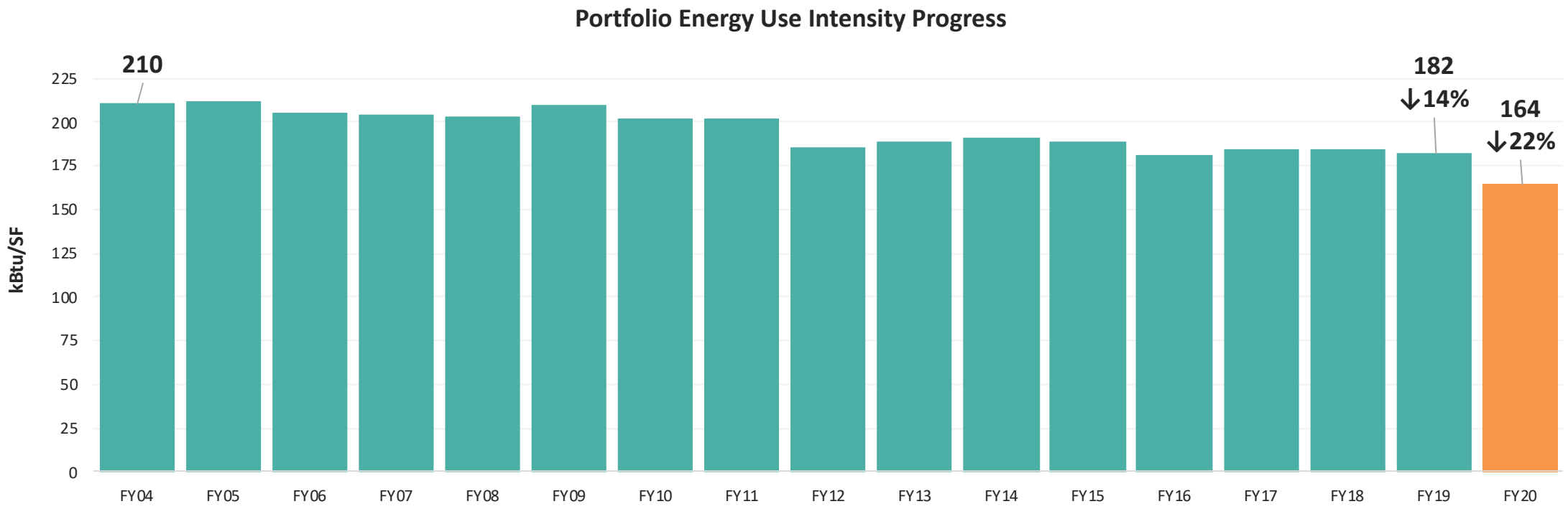
LBE Progress: Achieving Fuel Oil Reduction Targets

Portfolio must reduce fuel oil by ~34% (1.4M gallons) by 2025, from FY19 benchmark



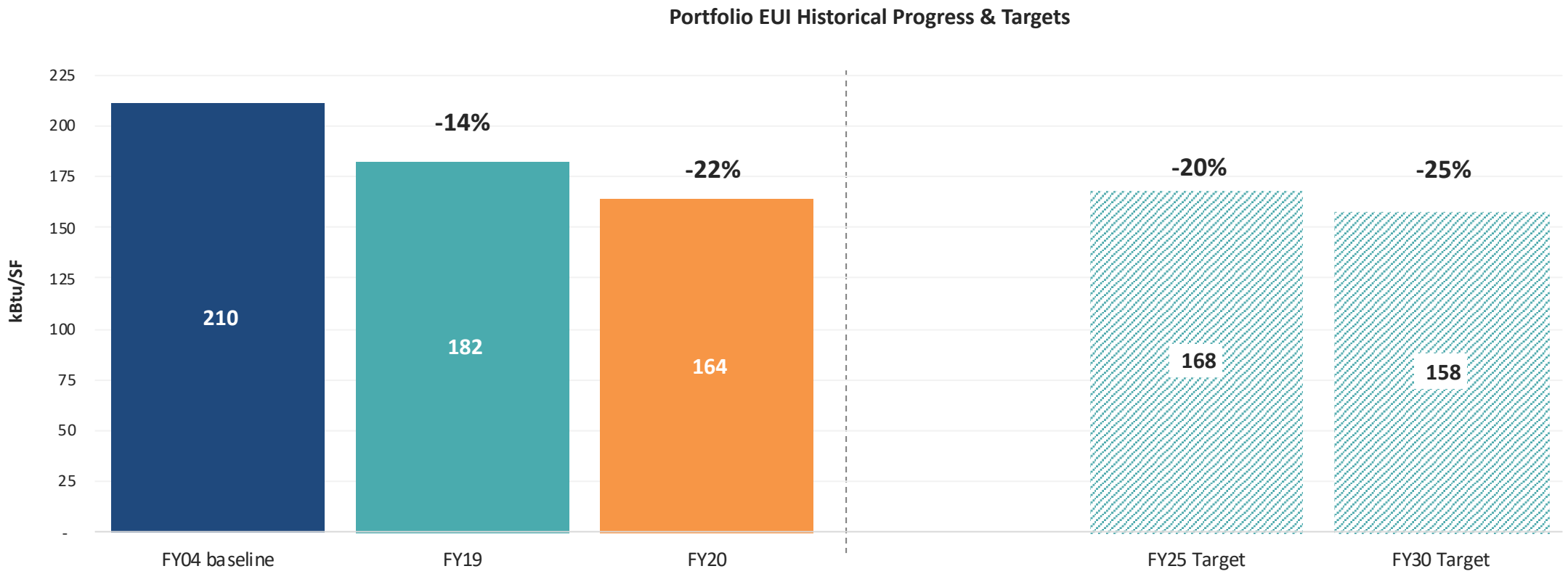
LBE Progress: Energy Use Intensity

- In FY20, overall energy use intensity was roughly 164 kBtu/SF, a 22 percent reduction over FY04
- Roughly a 10% change over FY19, resulting from portfolio efforts & COVID-related closures



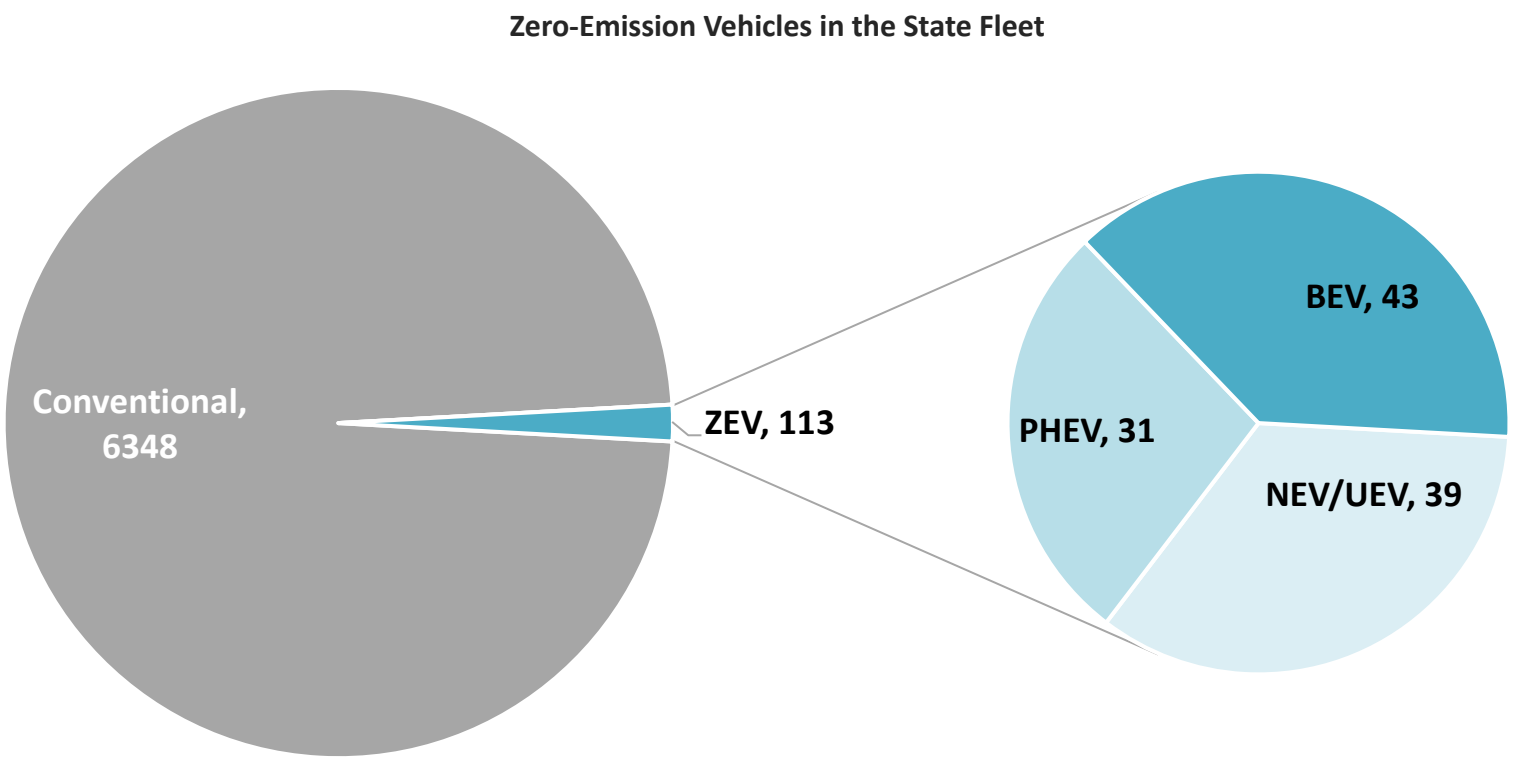
LBE Progress: Achieving Energy Use Intensity Targets

Portfolio must reduce overall EUI by ~7% (168 target EUI) by 2025, from FY19 benchmark



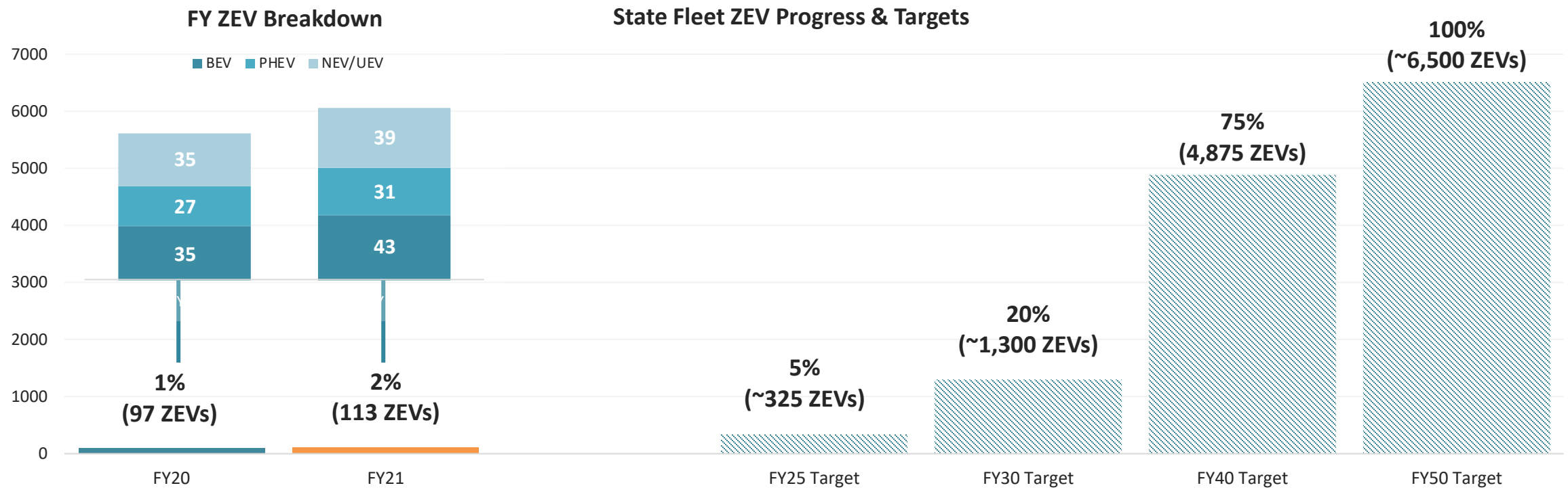
LBE Progress: Zero-Emission Vehicles

- Roughly 6,500 on-road vehicles in the state fleet
- Majority of fleet is lighter-duty (<14,000 GVWR), but truck and van heavy
- Currently ~2% are ZEVs (1% if excluding NEV/UEVs)



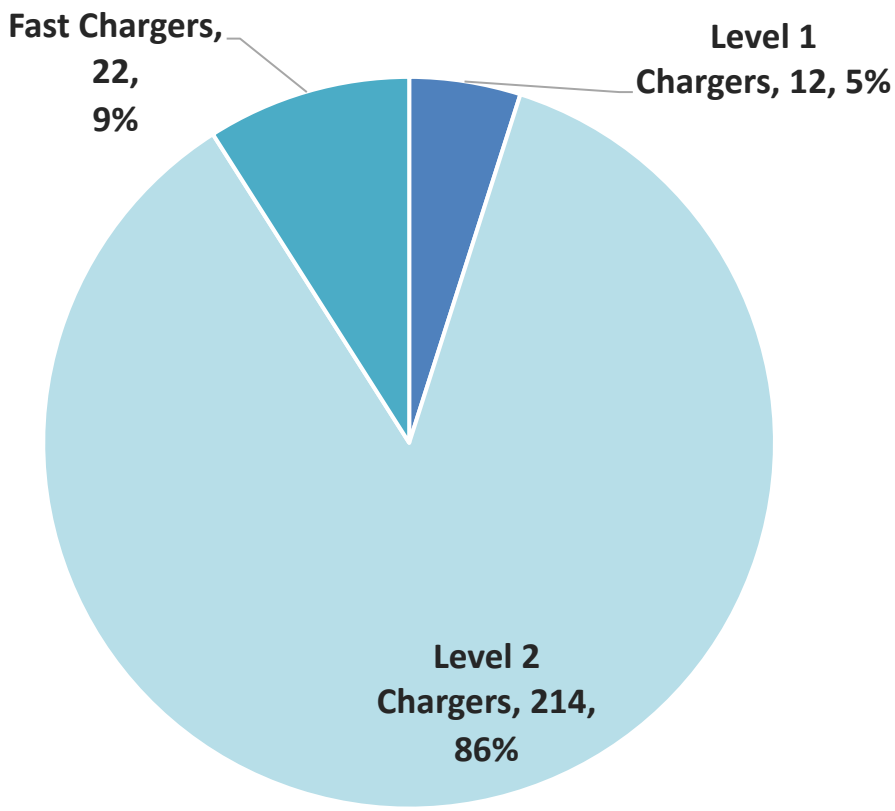
LBE Progress: Achieving Zero-Emission Vehicle Targets

Portfolio must acquire an additional ~215 ZEVs by 2025, from FY20 baseline



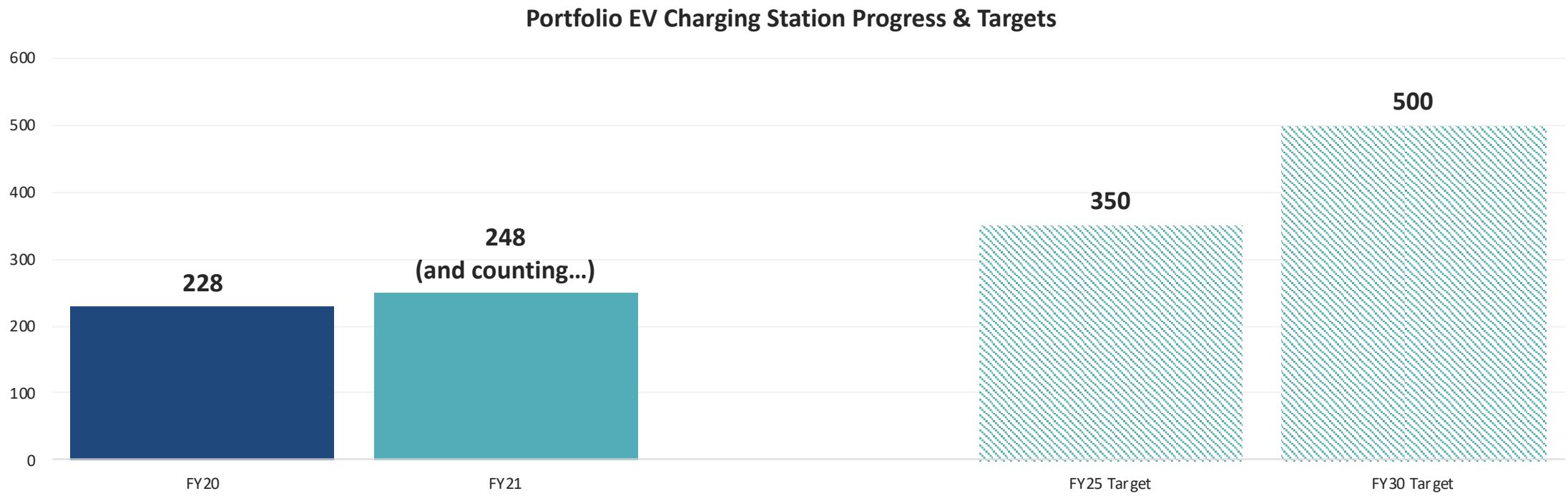
LBE Progress: EV Charging Stations

- 248 charging stations installed (possibly more once FY21 data are collected)
- 214 (86%) are level 2, with 22 DC fast chargers
- 2/3 are publicly accessible with no restrictions; ~35 are dedicated for fleet charging



LBE Progress: Achieving EV Charging Station Targets

Portfolio must install an additional ~100 EV stations by 2025, from FY20 baseline



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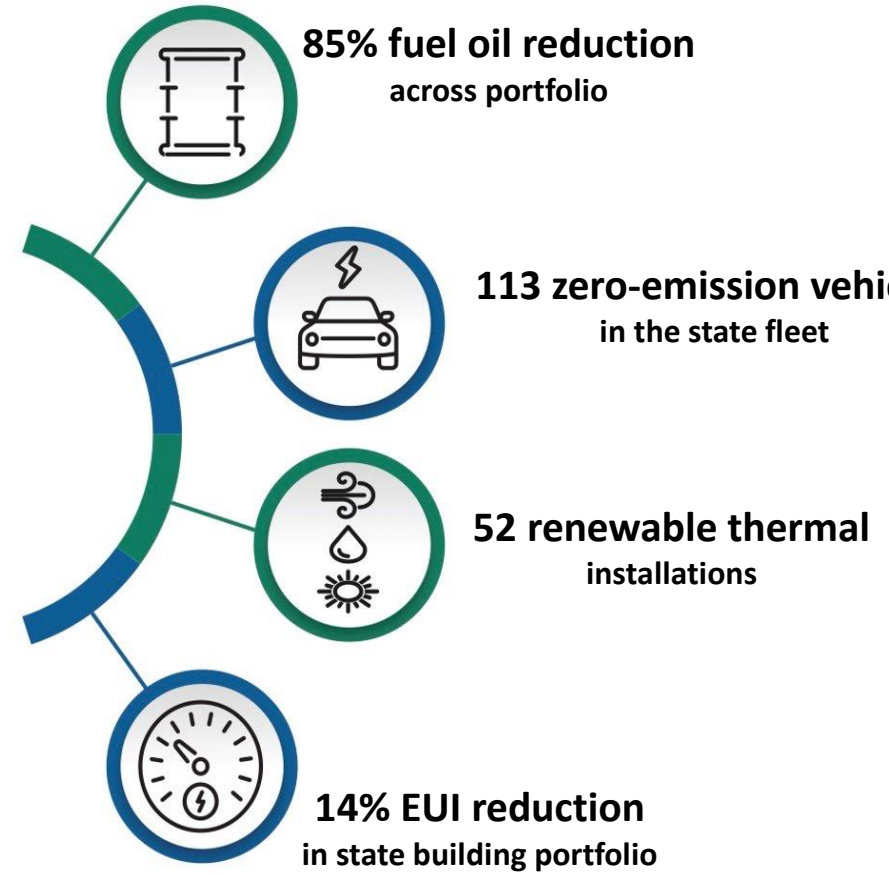
LBE Progress Summary

95 LEED Buildings
constructed

29 MW Solar PV
installed at state facilities

16% overall reduction
in onsite fossil fuels

248 EV charging
stations installed



85% fuel oil reduction
across portfolio

113 zero-emission vehicles
in the state fleet

52 renewable thermal
installations

14% EUI reduction
in state building portfolio

283 acres
of pollinator habitat!

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Heat Pumps 101

Efficient electrification with heat pumps

Outline

- Some basics
- Efficient Electrification
- Case Studies – New Construction
- Retrofitting considerations

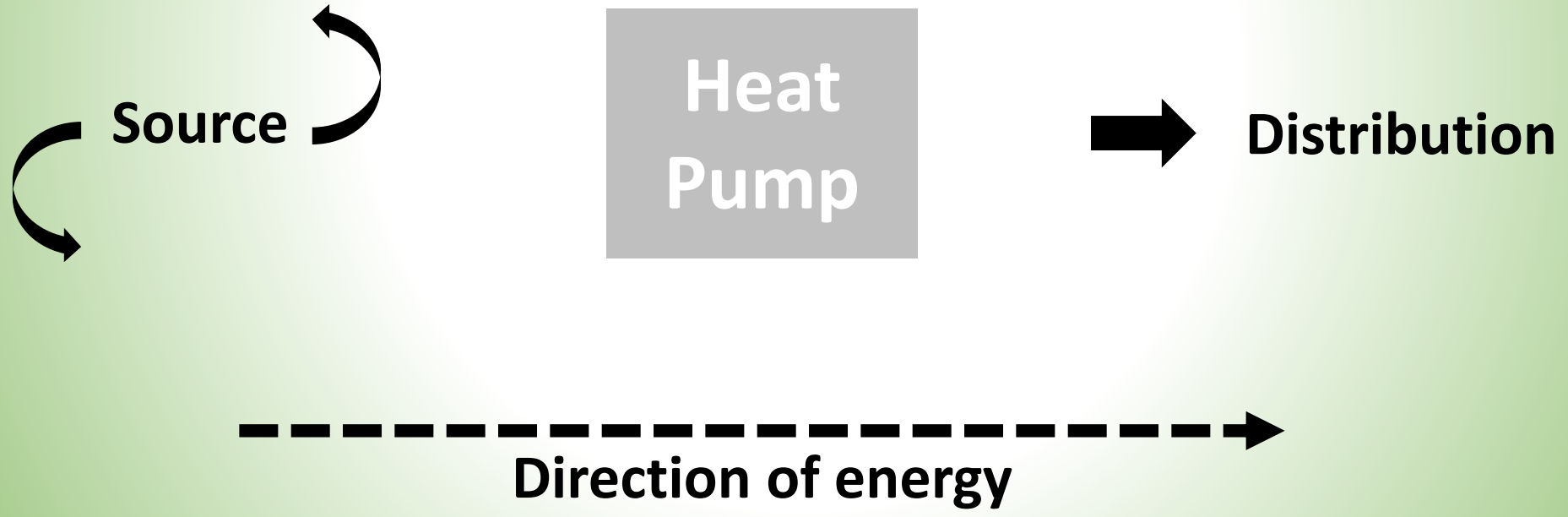
Definitions

*“i·lek·truh·fi·**kay**·shn”*

Electrification: **The process of swapping from fuel-based space and water heating to electricity-based space and water heating.**

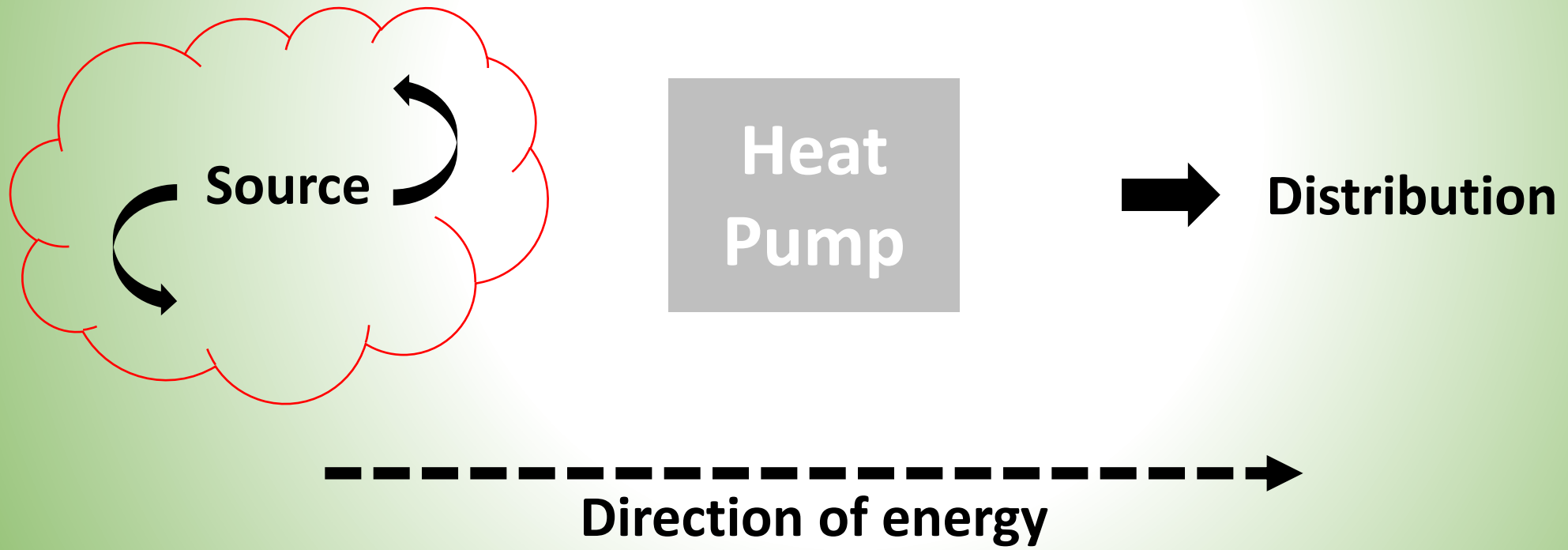
Efficient electrification: **Electrification using equipment with efficiencies in the order of 300%.**

Source and distribution



Source and distribution

Let's discuss "source" side first



Air source heat pump

Outside air

building

Air Source

Heat Pump

Distribution

ground

Ground source heat pump

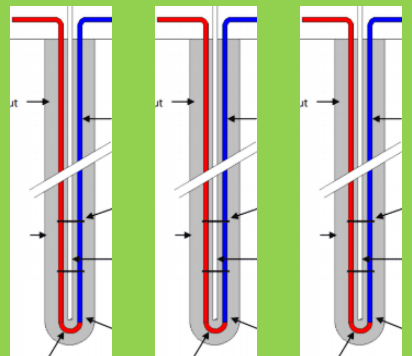
Outside air

building

Heat Pump

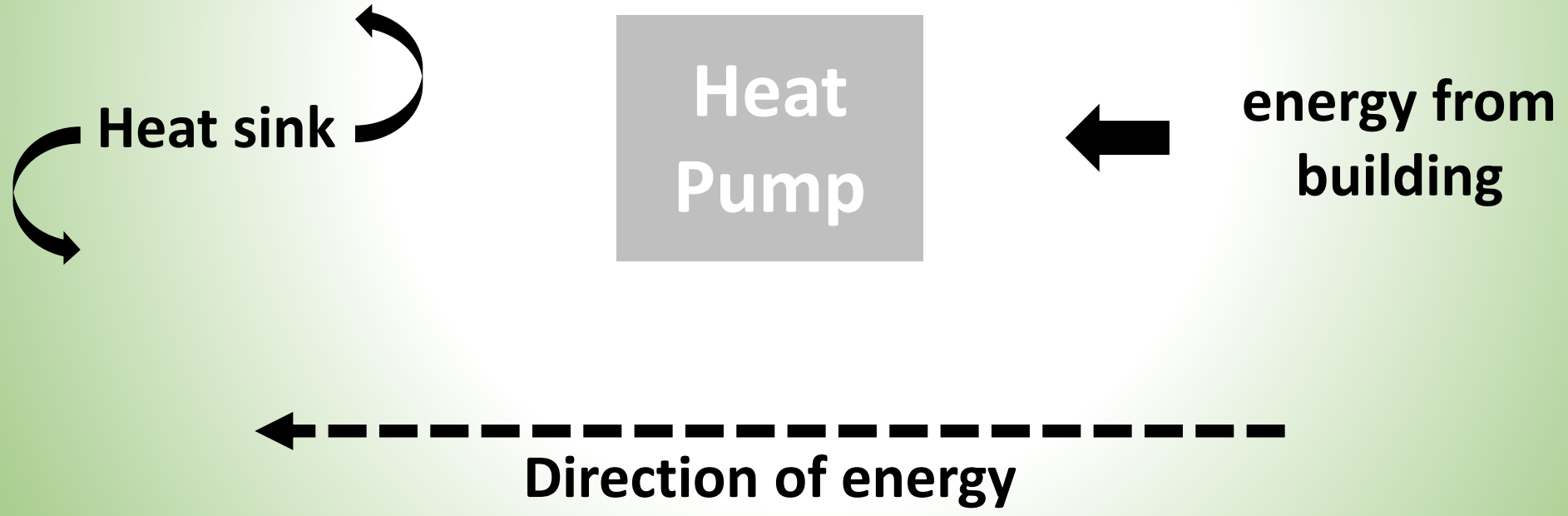
Distribution

Ground Source



ground

Using heat pump for cooling



Air source heat pump

Outside air

building

Heat sink to air

Heat Pump

energy from building

ground

Ground source heat pump

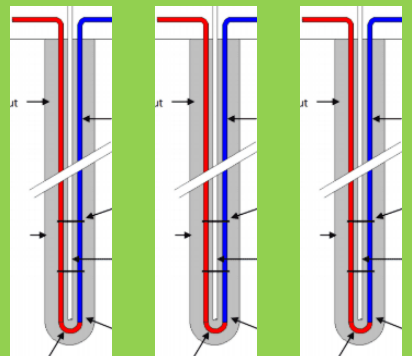
Outside air

building

Heat Pump

energy from building

Heat sink to ground



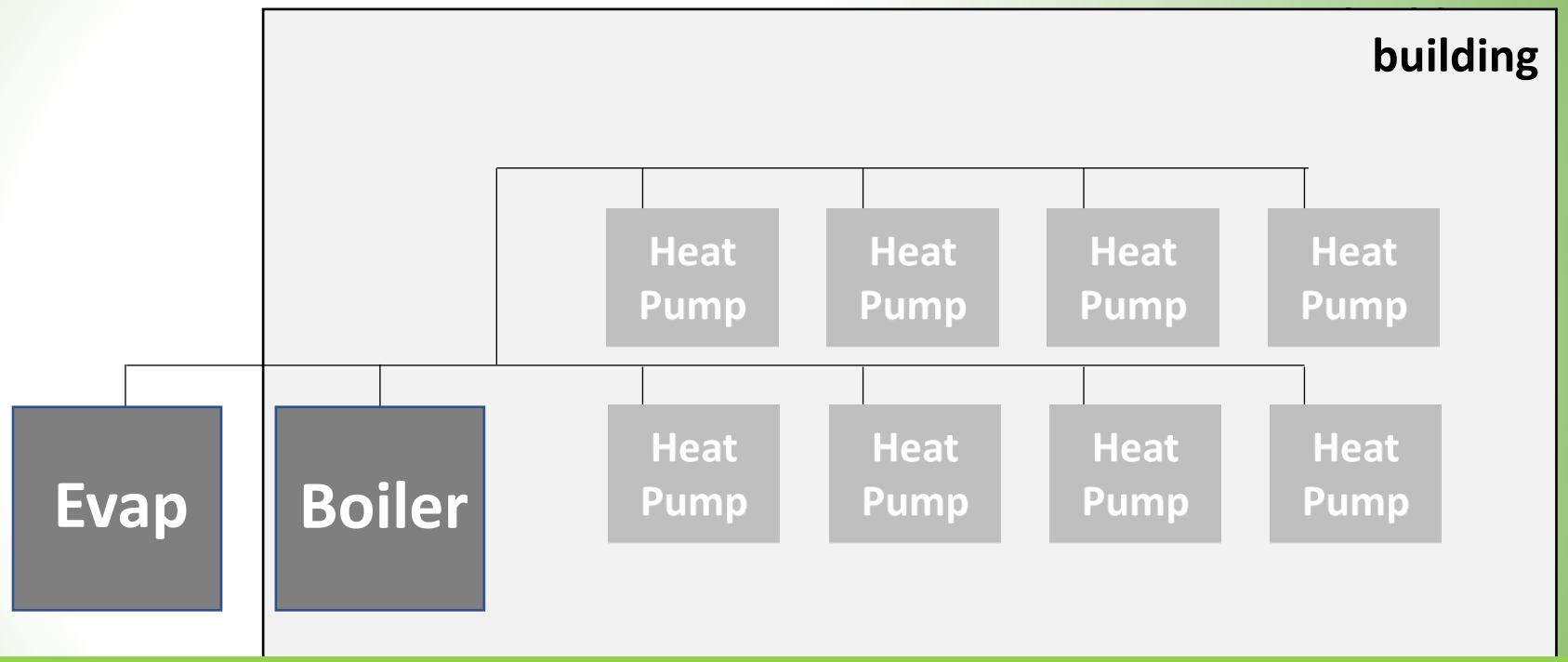
ground

Water source heat pump (aka “fuel source”)

In this system, a boiler and an outdoor evaporative unit maintain a source of water at steady temperature which is supplied to pumps in the building.

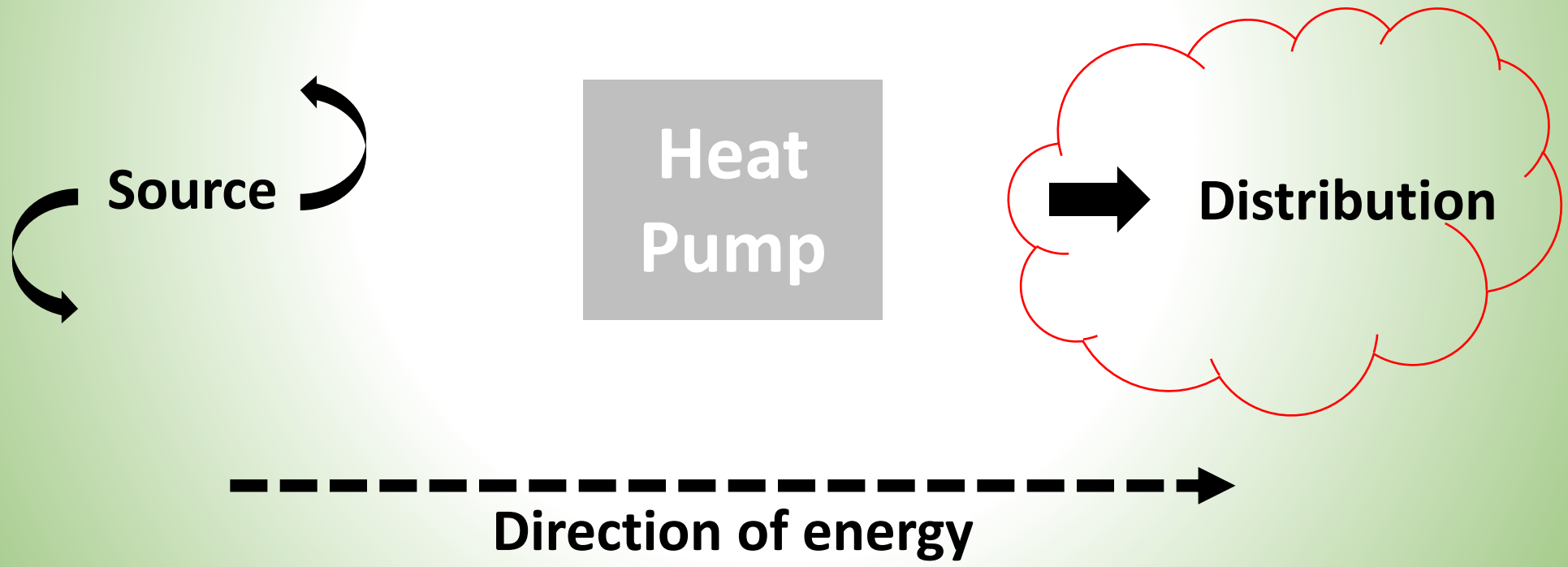
In this case, the source of the BTUs is neither the ground nor the air – the source is fuel.

This approach is not electrification!

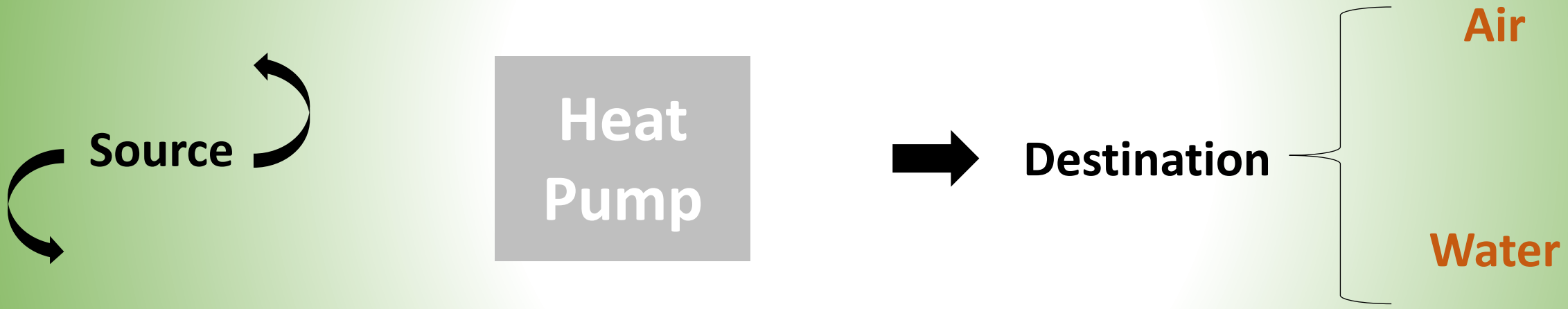


Source and distribution

Let's discuss "distribution" side



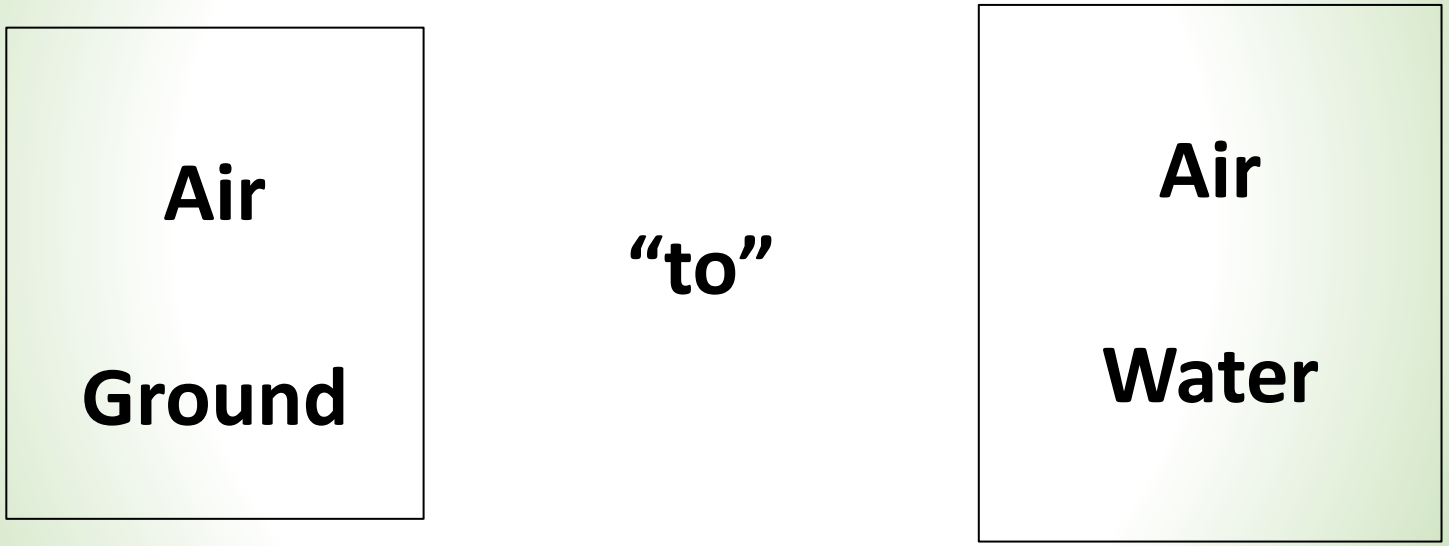
Two media for distribution into building



Direction of energy

Heat pumps make hot/cold water or hot and cold air – the distribution side of things can look just like any other building

Classifying heat pumps for efficient electrification (4 permutations!)



Classifying heat pumps (4 permutations!)

Air **Ground**	**“to”**	**Air** **Water**

Fun Fact!

A “variable refrigerant flow” or VRF system is a kind of air to air (or ground to air) system which distributes the destination air deep into the building floorplate. A VRF system is just a kind of heat pump!

Outline

- Some basics
- Efficient Electrification
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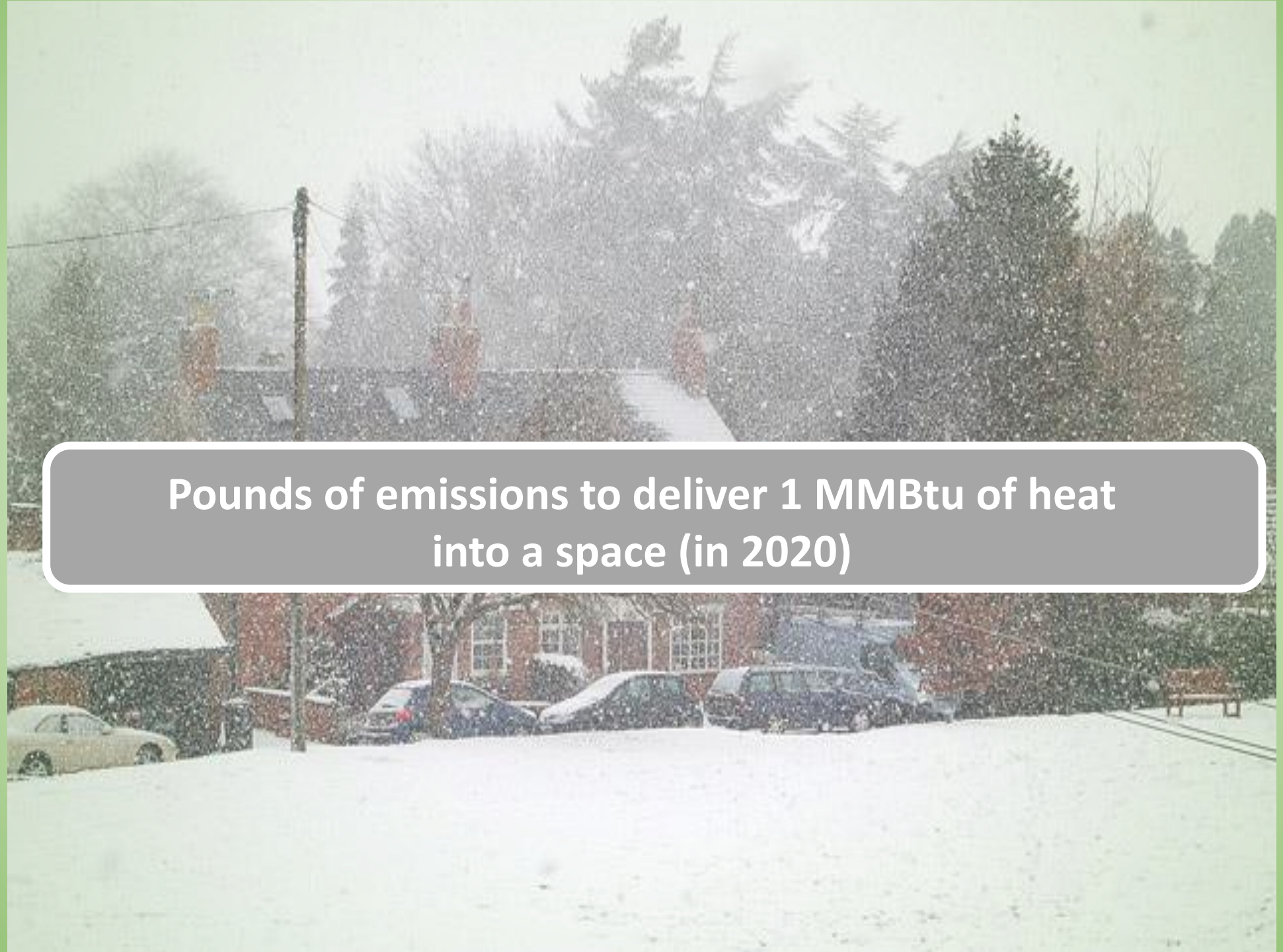
- Retrofitting considerations



Pounds of emissions to deliver 1 MMBtu of heat into a space (in 2020)

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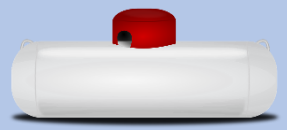
OIL	PROPANE	GAS
		

Pounds of emissions to deliver 1 MMBtu of heat into a space (in 2020)

170	145	120

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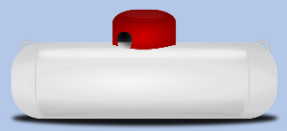
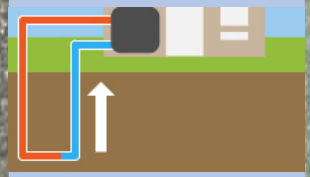
OIL	PROPANE	GAS	ELECTRIC Resistance	ELECTRIC COLD CLIMATE AIR SOURCE HEAT PUMP	ELECTRIC GROUND SOURCE HEAT PUMP
					

Pounds of emissions to deliver 1 MMBtu of heat into a space (in 2020)

170	145	120	193	60	43

50% Less

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Electric Grid Emissions: Lower each Year

Hydropower

Solar

Wind

Massachusetts electric grid emissions decline each year with investment in hydro, solar, and wind.

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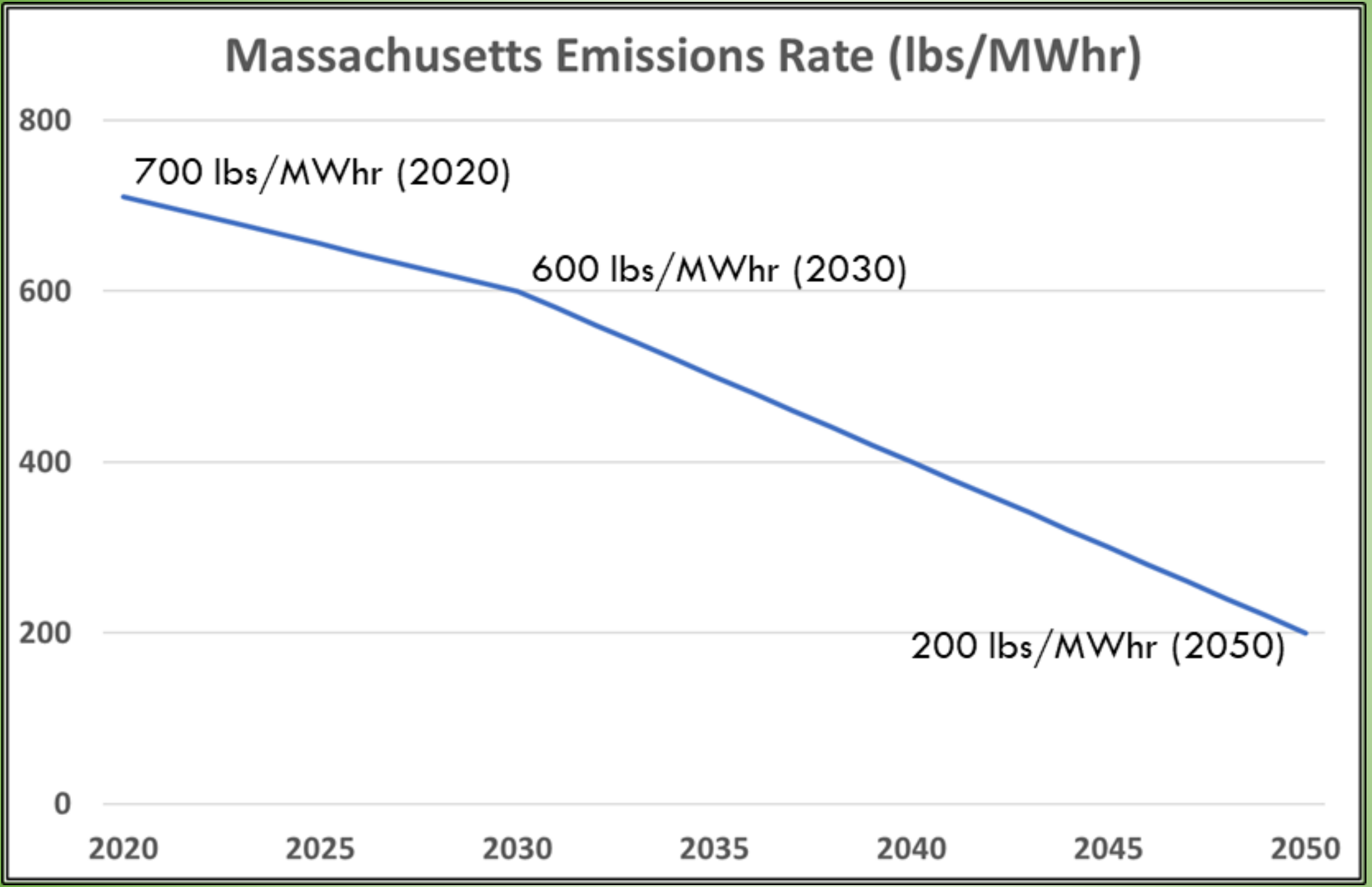

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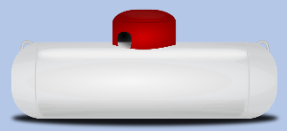
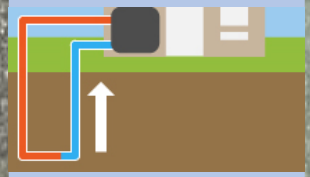
OIL	PROPANE	GAS	ELECTRIC Resistance	ELECTRIC COLD CLIMATE AIR SOURCE HEAT PUMP	ELECTRIC GROUND SOURCE HEAT PUMP
					

Pounds of emissions to deliver 1 MMBtu of heat into a space (in 2050)

170	145	120	~~193~~ 60	~~60~~ 18	~~43~~ 13

85% Less

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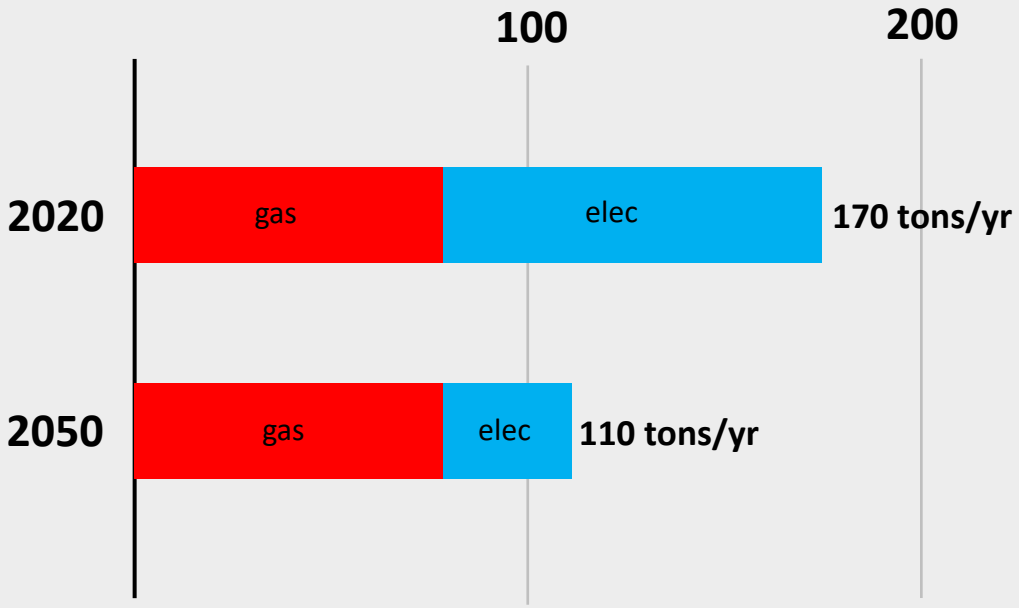
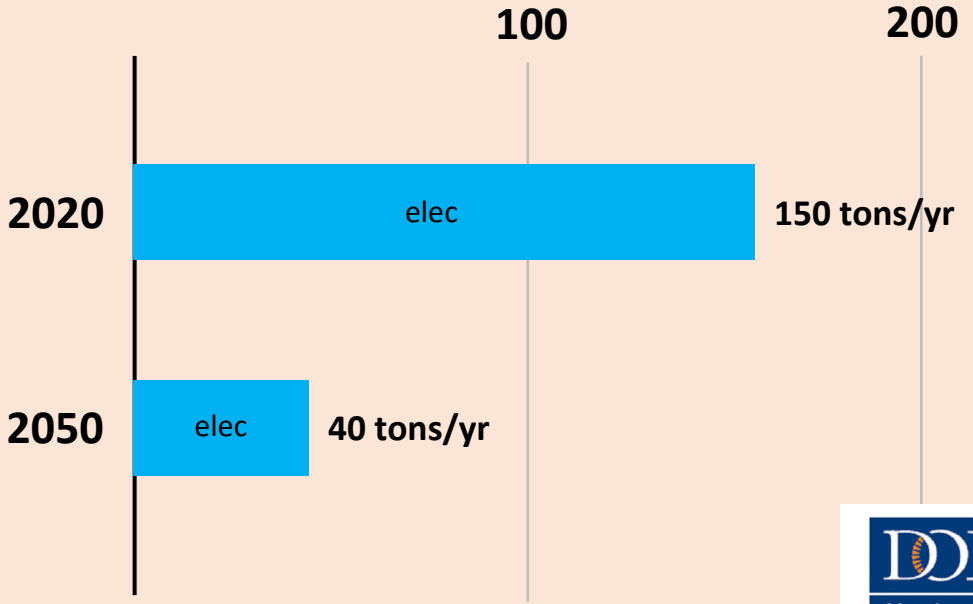
50,000-sf multifamily

- 95% natural gas space heating
- 95% natural gas water heating



50,000-sf multifamily

- 320% air source heat pump space heating
- 250% air source heat pump water heating



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Outline

- Some basics
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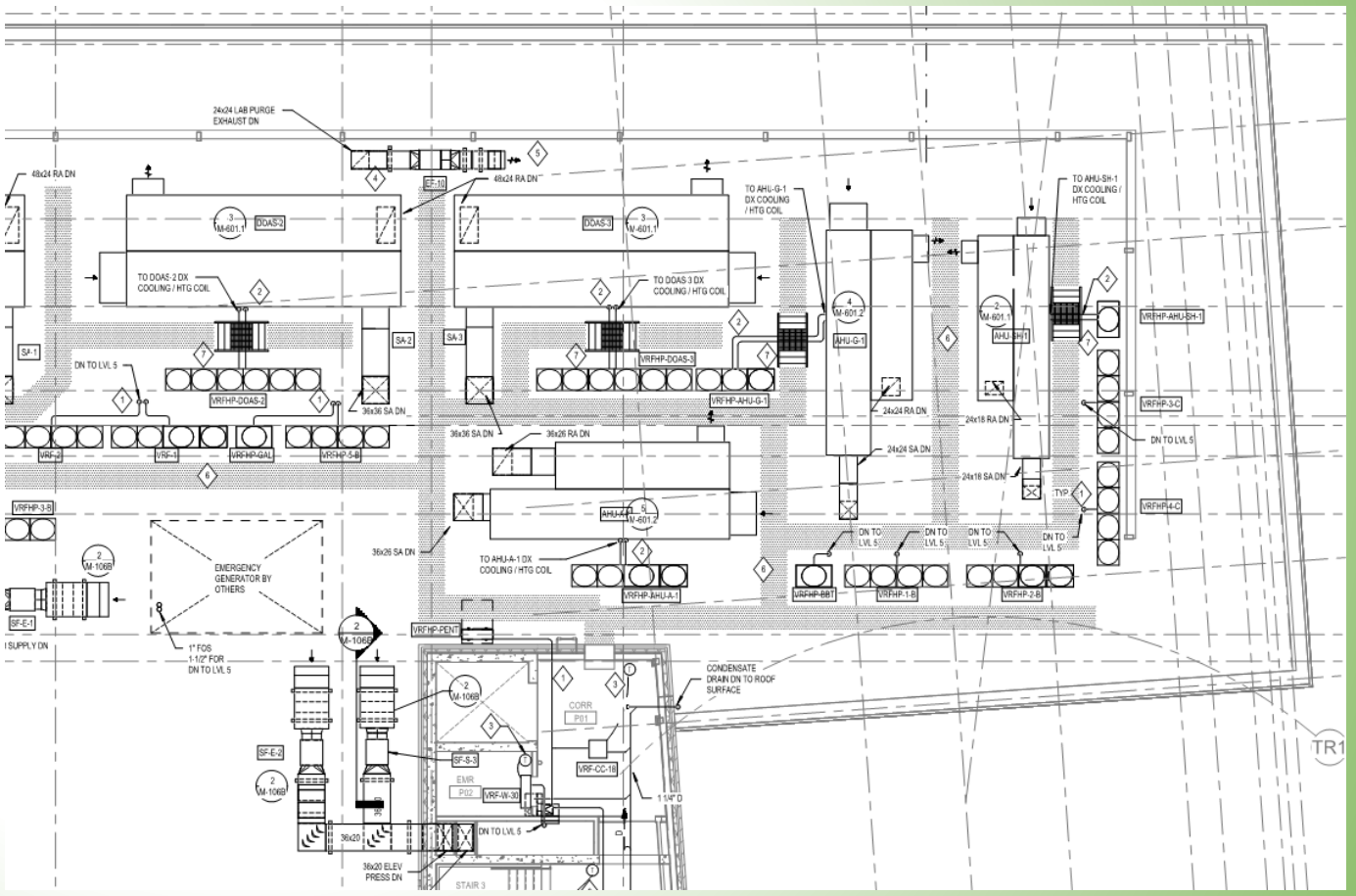
New Construction – Air to Air
Walden Visitor Center

- Variable Refrigerant Flow Heat Pump
- 6,000 sf vaulted ceilings, large open spaces
- Focus on energy efficient design w/ super insulation and triple-glazed windows.
- Net-zero with onsite PV

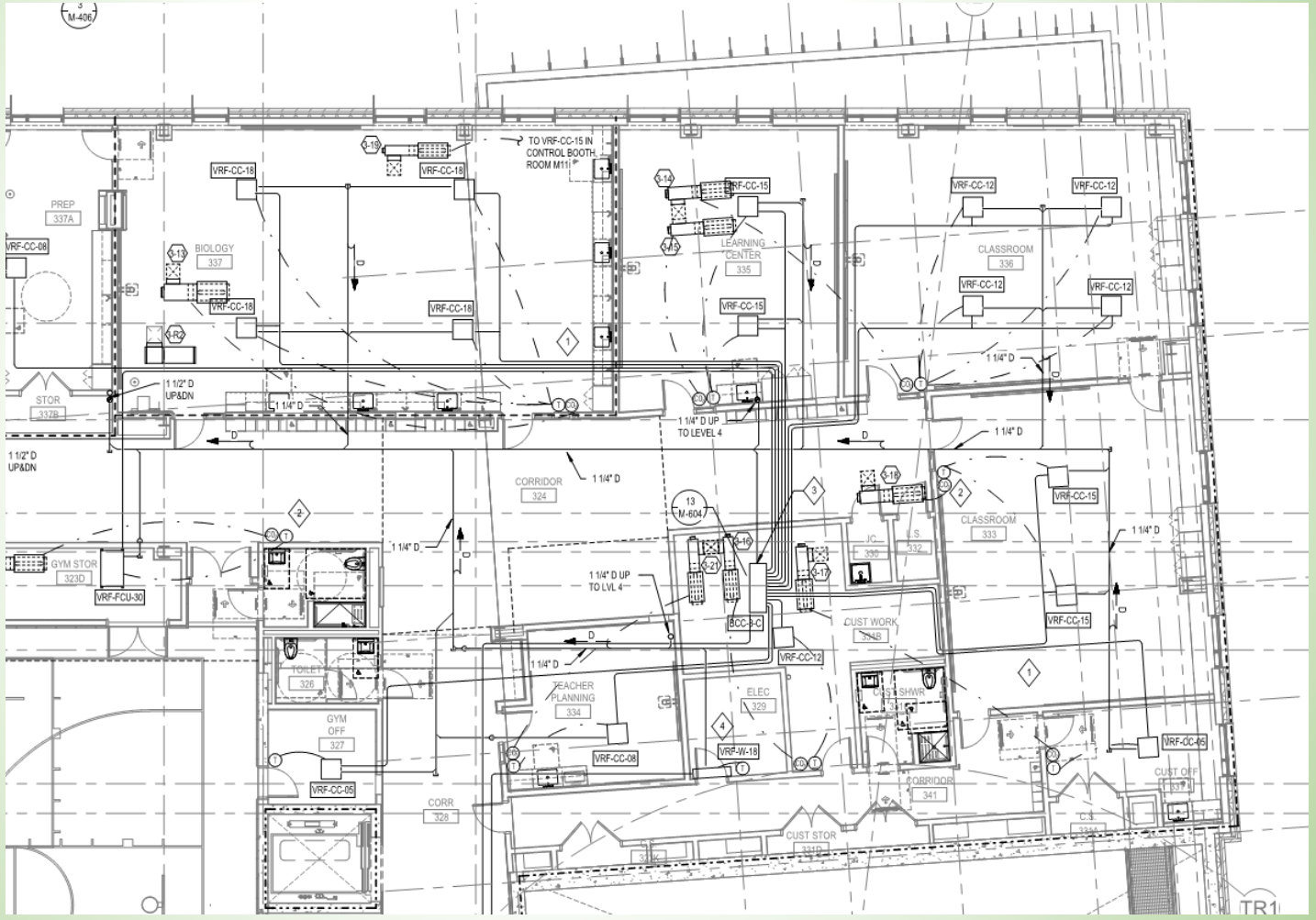
BPS Boston Arts Academy – Air-to-Air (VRF)

BPS Boston Arts Academy – Air-to-Air (VRF)

- High school – approx. 150,000 sf
- VRF integrated into air handling units and zone heating/cooling
- Heat recovery – simultaneous heating and cooling



BPS Boston Arts Academy – Air-to-Air (VRF)



New construction – Ground to water Sbrega Science and Health Science Building

- High Performing Building Envelope
- Energy Recovery Ventilation
- Targeted laboratory ventilation
- Ground to Water Heat pump

New construction – Ground to air/refrigerant Chelsea Soldiers' Home

- High Performing Building Envelope
- Energy Recovery Ventilation
- Ground (water) source heat pump AHU
- Ground (water) source VRF zone heating and cooling

New construction – Ground to air/refrigerant Chelsea Soldiers' Home

Ground-source VRF

Ground-source DHW

Air-to-water heat pumps

- An air-to-water heat pump is analogous to a boiler and chiller. This is familiar. Little or no perceived changes outside the mechanical room.
- Works with **hydronic distribution** (hot water heating)

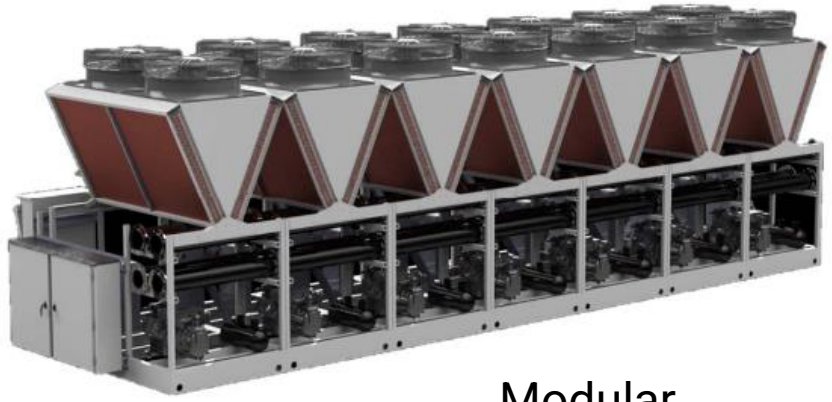
- Most cost-effective in medium and large buildings (>25,000 sf)
- Can supply 100% of heating (low/medium EUI buildings) or hybrid electrification (large buildings with high EUI)

- New construction – decoupled systems are best
- Retrofit – connect to existing hydronic distribution. Consider expanding use of hydronic heating. Retrofit for low-temperature hot water and decoupled systems.

Air-to-water heat pumps

- Good: distribute hot water to preheat (air handler) and reheat (zone) coils. Assumes DX cooling (air), no chilled water. Common in smaller buildings. VRF may be better application.
- Better: distribute hot water to preheat and reheat coils. Chilled water coils in AHU. Opportunities for heat recovery.
- Best: decoupled system. Distribute hot water and chilled water to AHU and zone terminals (fan coil units, fan powered boxes, chilled beams)

Air-to-water heat pumps



Modular

Packaged

2-Pipe HW or CHW

4-Pipe HW and CHW

Temperature and COP

Ambient temperature ↓ COP ↓

Hot Water Temperature ↓ COP ↑

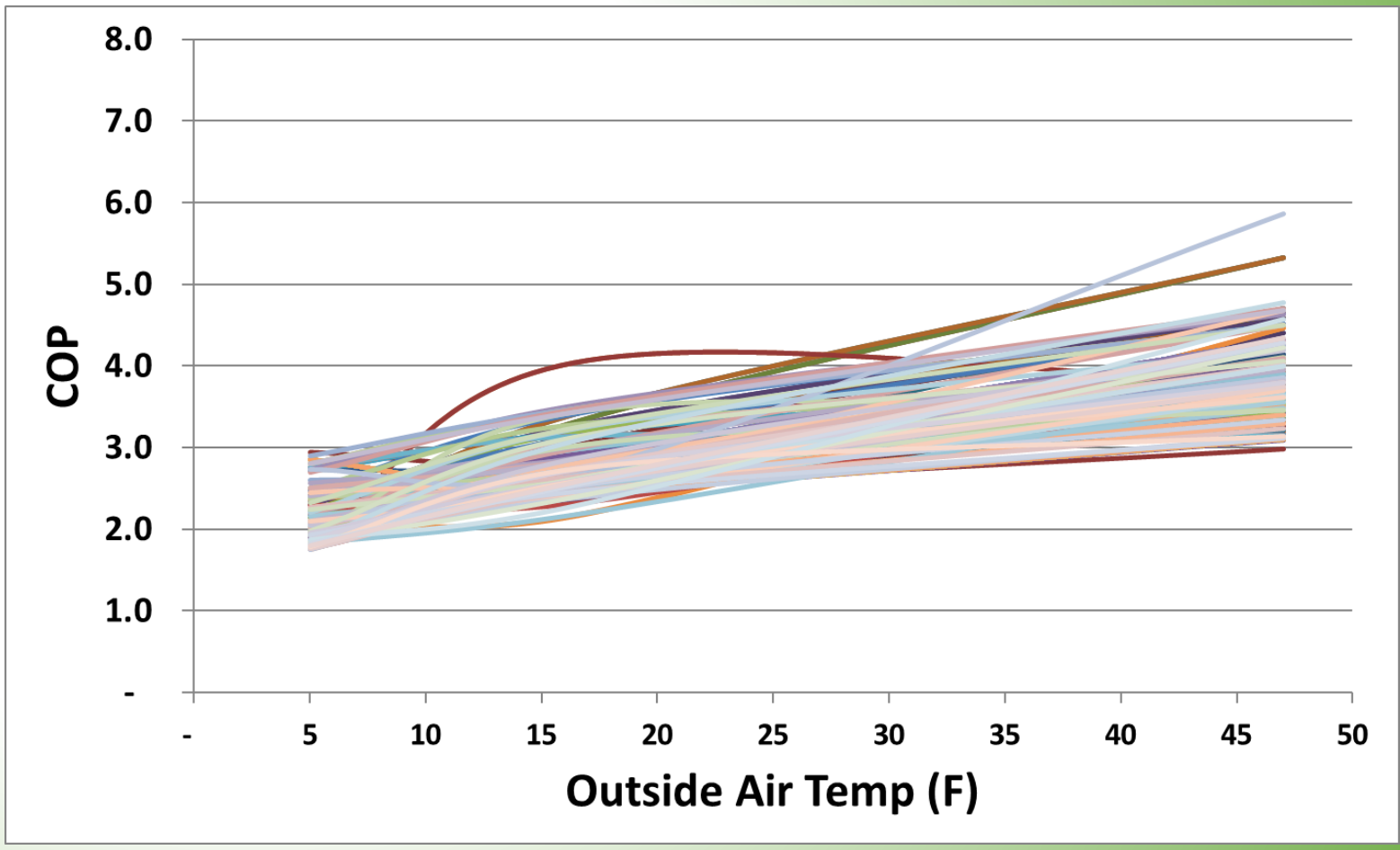
How low is too low?

Heating Mode Performance			
Ambient Temp (°F)	**HW Supply Temp** (°F)	**Output Capacity** MBH	**Efficiency** COP
-10	170	355	1.85
0	**170**	**450**	**1.87**
10	170	450	2.02
30	170	450	2.2
50	170	450	2.27
-10	145	338	1.87
0	**145**	**400**	**2**
10	145	400	2.11
30	145	400	2.39
50	145	400	2.75
-10	120	292	2.3
0	**120**	**364**	**2.31**
10	120	364	2.62
30	120	364	2.99
50	120	364	3.28
-10	100	275	2.41
0	**100**	**339**	**2.56**
10	100	339	2.88
30	100	339	3.37
50	100	339	3.67

Do heat pumps need gas “backup” if too cold? (Answer: **No**)

Back-in-the-day, heat pumps did not work below about 40 F.

Today, heat pumps work down to **negative 15 F** and have x2 to x3 better efficiency than gas systems at 5 F.



Building Efficiency

- Step 1: make your building energy efficient (load reduction)
- Step 2: evaluate heating load
- Step 3: low temperature hot water
- Step 4: Heat recovery chiller (electrification)
- **Step 5: Heat pump (electrification)**

Air-to-water heat pumps – Pros/Cons

Pros

- Cost (no drilling)
- COP
- Flexibility (location)
- Predictable Capacity
- Scalability
- Retrofit
- Eligible for utility incentives
- Eligible for alternative energy credits (3x multiplier, 5x for ZNE)

Cons

- Space
- HW Temperature
- Noise
- Glycol

Outline

- Some basics
- Efficient Electrification
- Case Studies – New Construction
- Retrofitting considerations

Retrofits: Envelope performance

Heat pump heating is **lower temperature** than heating with fossil fuel furnace or boiler.

If the building being retrofitted is leaky, swapping from fossil fuel to heat pump equipment can result in serious complaints

It's **essential** that **air leakage and envelope performance be addressed first in a retrofit.**

Retrofits: Compatibility

In many existing buildings, the fan coils, radiators, and other terminal units are designed to receive high-temperature hot water.

Heat pump output is usually **lower temperature** than these units were initially designed for.

A designer needs to **carefully assess** the terminal units to evaluate possible performance impacts with lower temperature inputs. **Terminal unit modifications may be required**.

TEMPERATURE AND COP

Coil Selection

Water-to-Water Booster

Retrofits: VRF

VRF systems are very flexible and a good choice for existing buildings, including historic structures.

The new VRF system can be independent of any existing HVAC systems and thus **terminal unit compatibility is a non-issue.**

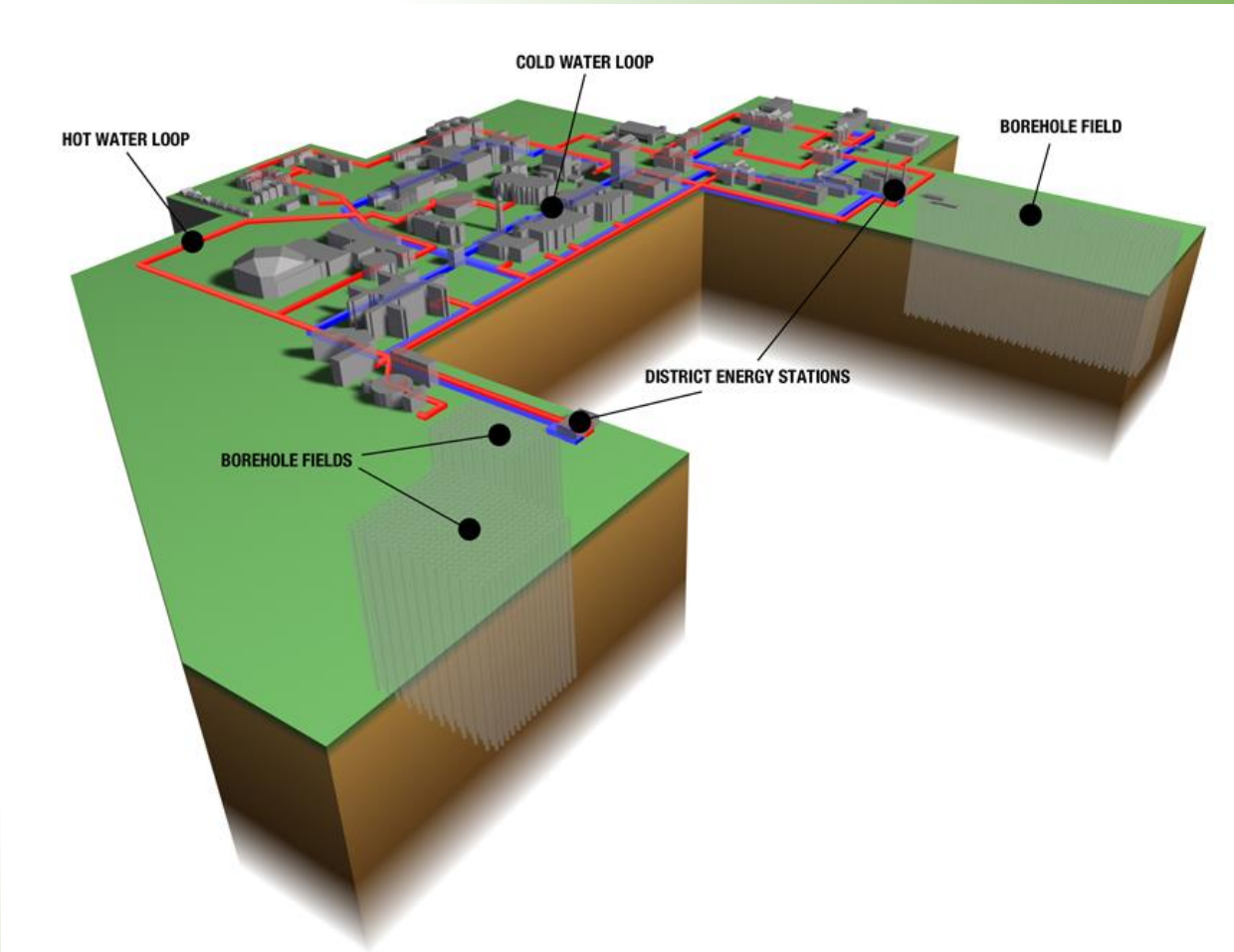
The pictures are of the Mackie Building (Milwaukee, WI) which was retrofitted with air source VRF.

Ball State: District Ground to Water System

Ball State is an example of a ground to water heat pump systems which serves a group (district) of buildings.

Massachusetts has many district steam systems. Retrofitting steam systems to ground to water would require (1) complete replacement of the steam plant and distribution network and (2) retrofitting all buildings' terminal units to accommodate lower temperature water.

(Keep in mind, the new ground to water system would be heating **and cooling**)

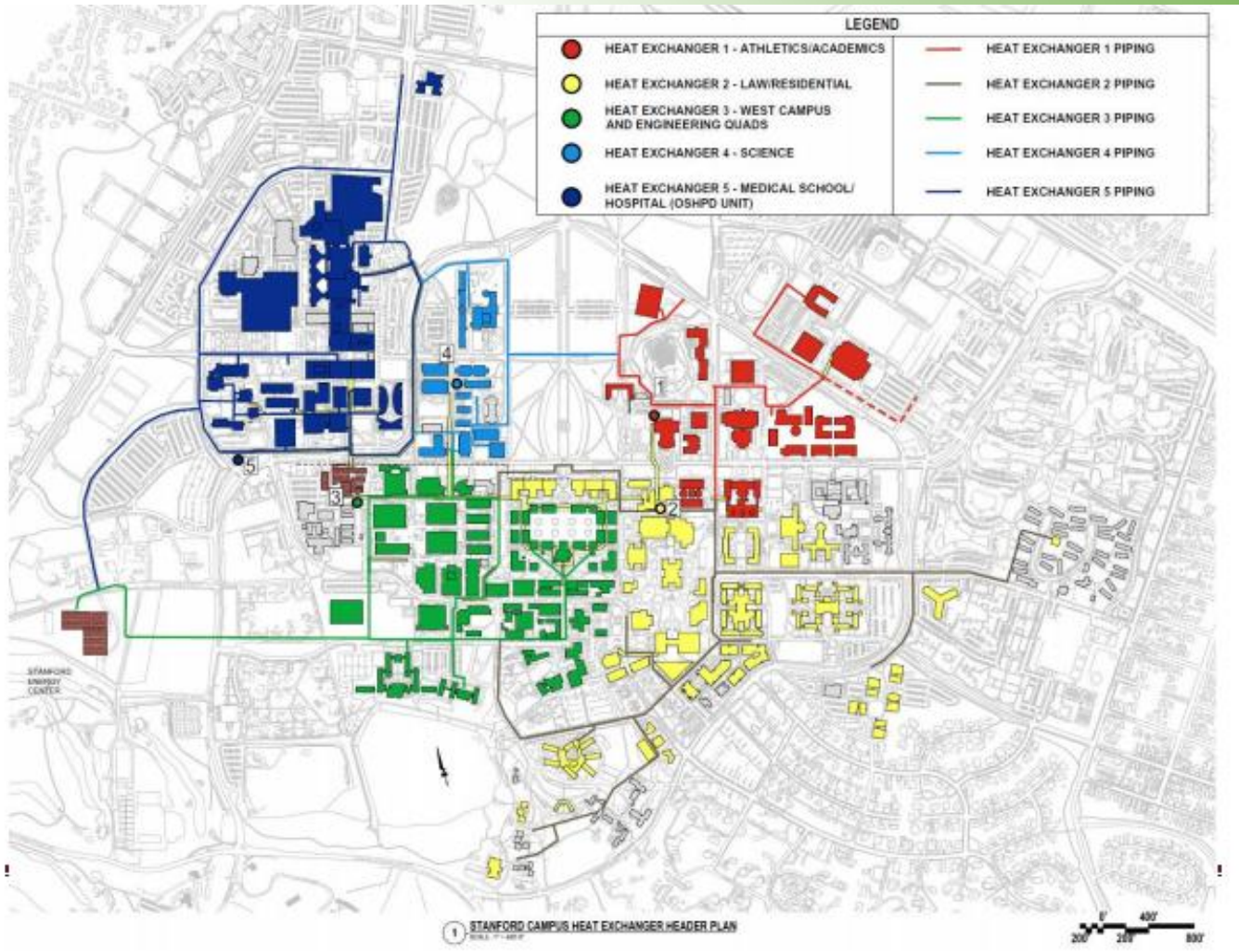


Stanford: District Air to Water System

Stanford is an example of an air to water heat pump systems which serves a group (district) of buildings.

Transitioning from steam to air to water would also require (1) complete replacement of the steam plant and distribution network and (2) retrofitting all buildings' terminal units to accommodate lower temperature water.

This air to water systems does heating and cooling.



Heat pump service water heating

Don’t forget service water heating!

Off the shelf, heat pump service water heating appliances are readily available and can be used in homes, townhouses, and offices.

DOER
Massachusetts Department of Energy Resources

Heat Pumps: Public Entity Perspectives

Woburn Senior Center
ASHP

HEAT PUMP PROJECT OVERVIEW

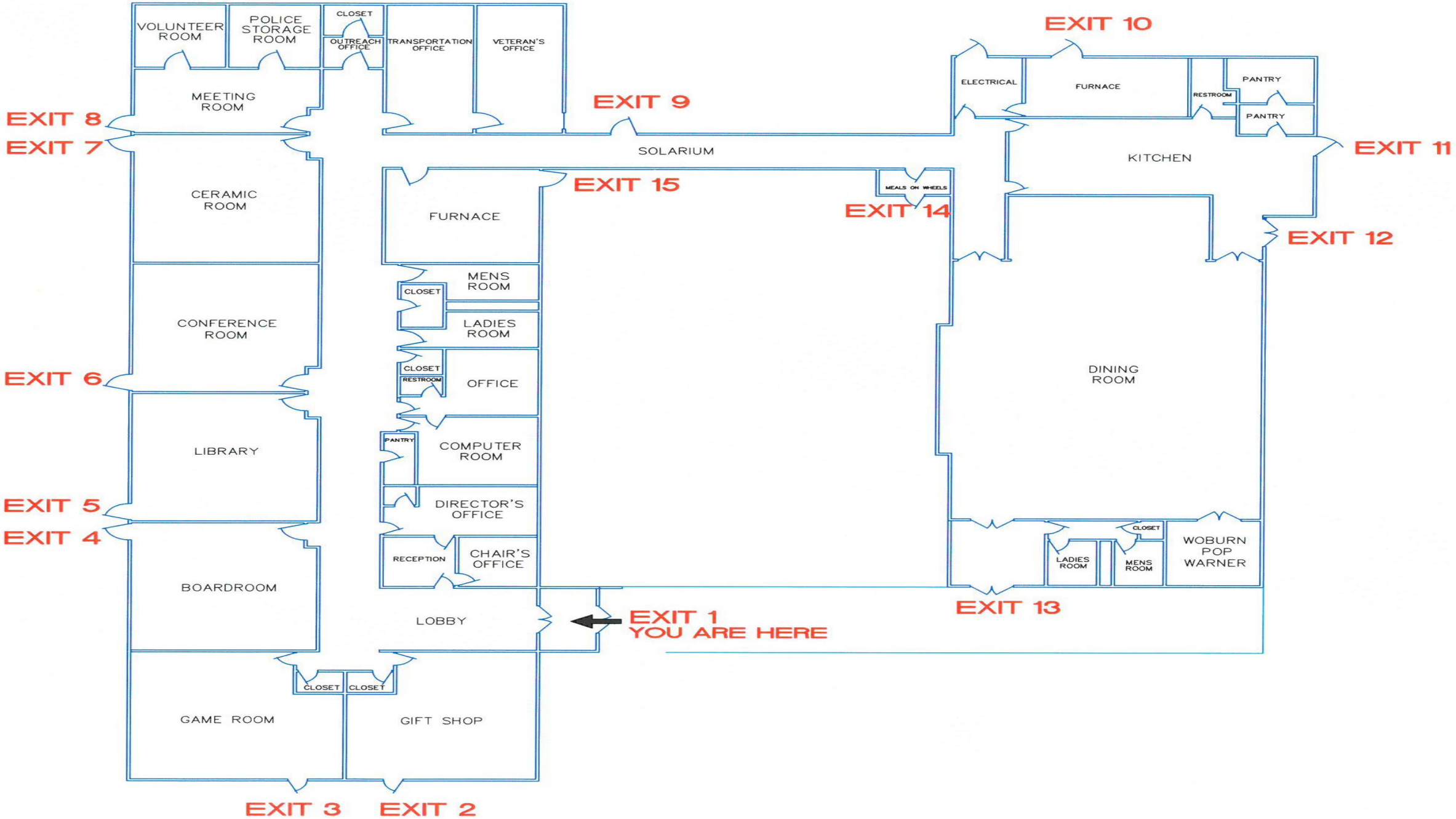
- In an effort to meet the city's energy reduction goals we installed Air Source Heat Pumps (ASHPs) to replace 2 oil fired furnaces and more than a dozen window AC units
- Working with Spark and Horizon on a phased approach the project was completed over 2 years, in two phases
- With all projects especially those on older buildings there were many obstacles (Power, Hazardous materials, Mounting locations)

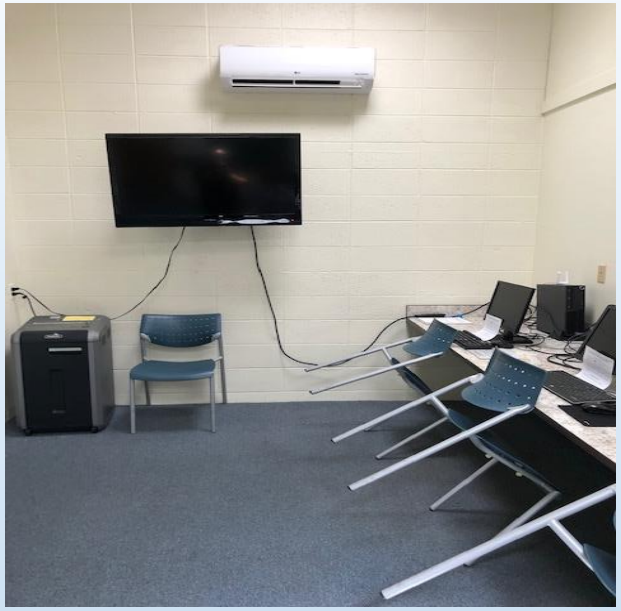
RESULTS: *SAVINGS and COMFORT*

- Seniors and staff are more comfortable
- Electricity use has dropped by about 18%
  - 40,000-55,000 kWh annually.
  - Roughly $8,000-$10,000 in savings.

- Heating oil use has gone to almost zero, saving about 7,500 gallons of oil annually. $10,000-$20,000 savings, depending on oil prices.

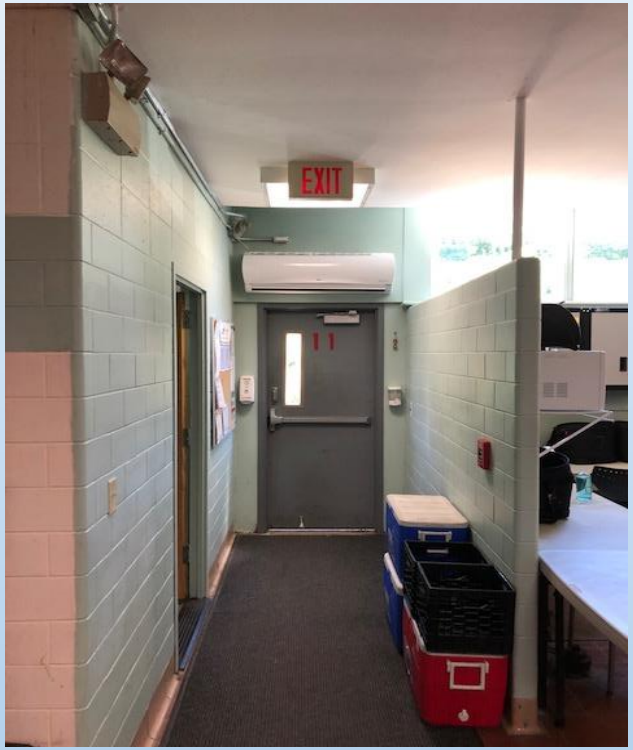
- Total estimated annual savings $18,000+


VOLUNTEER ROOM
POLICE STORAGE ROOM
CLOSET
OUTREACH OFFICE
TRANSPORTATION OFFICE
VETERAN'S OFFICE
MEETING ROOM
EXIT 8
EXIT 7
EXIT 9
EXIT 10
ELECTRICAL
FURNACE
RESTROOM
PANTRY
PANTRY
SOLARIUM
KITCHEN
EXIT 11
CERAMIC ROOM
EXIT 15
FURNACE
MEALS ON WHEELS
EXIT 14
EXIT 12
MENS ROOM
CLOSET
LADIES ROOM
CONFERENCE ROOM
CLOSET
RESTROOM
OFFICE
EXIT 6
DINING ROOM
LIBRARY
PANTRY
COMPUTER ROOM
EXIT 5
DIRECTOR'S OFFICE
EXIT 4
RECEPTION
CHAIR'S OFFICE
CLOSET
LADIES ROOM
MENS ROOM
WOBURN POP WARNER
BOARDROOM
LOBBY
EXIT 1
YOU ARE HERE
EXIT 13
CLOSET
CLOSET
GAME ROOM
GIFT SHOP
EXIT 3
EXIT 2




LG


LG
BOARD OF HEALTH
NURSE'S
OFFICE
VETERAN
OFFICE


EXIT

Lessons Learned

- Planning, Planning, Planning !!!
- Things to Consider:
  - Your Building Management System
  - The Building’s Power Capacity
  - Condensate Drains When Choosing Equipment
- Potential hazards from building materials
- Types of equipment:
  - Wall Units
  - Ceiling Cassettes
  - Cold climate
  - VRF
- Training for staff and maintenance personnel, manuals & warranty's
- Added equipment needed to connect to building management sys.

This has been a great project for the Woburn Senior Center

Staff and seniors alike have really enjoyed the climate comfort

Woburn is benefitting from the energy savings

Success of this project would not have been possible without:

Susan McPhee from Spark

Mike Sciaraffa from Horizon Solutions

Paul Medeiros Woburn Facilities

Marie Lingblom Woburn Senior Center Director

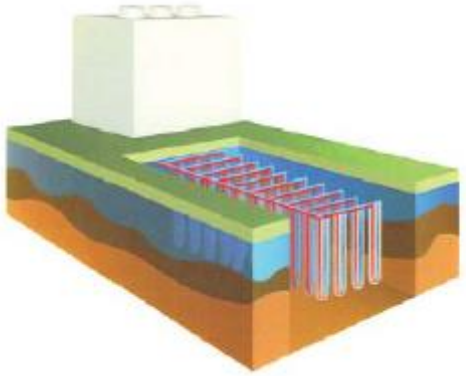
Scott Galvin Mayor City of Woburn

Please feel free to contact us if you have any questions

Ground Source Heat Pump at the ABS Information Commons

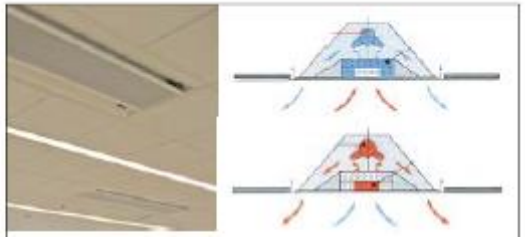
MASSACHUSETTS MARITIME ACADEMY PRESENTATION BY:

Kathy Driscoll - Director of Safety & Sustainability



GEOTHERMAL ENERGY

The concept of geothermal heating & cooling takes advantage of the ground as a mechanism for heat exchange. The system works by circulating water through a series of closed loop wells - in this case 48 wells, each 400 feet deep and 20 feet apart. The water is brought into the building through a heat pump and distributed through systems such as the radiant floor and chilled beams. After being pushed through the building the heated or cooled water is then brought back out to the wells for recharging.



CHILLED BEAMS

Efficient heating and cooling is provided by chilled beams which eliminate VAV boxes and utilize the water from the geothermal system.

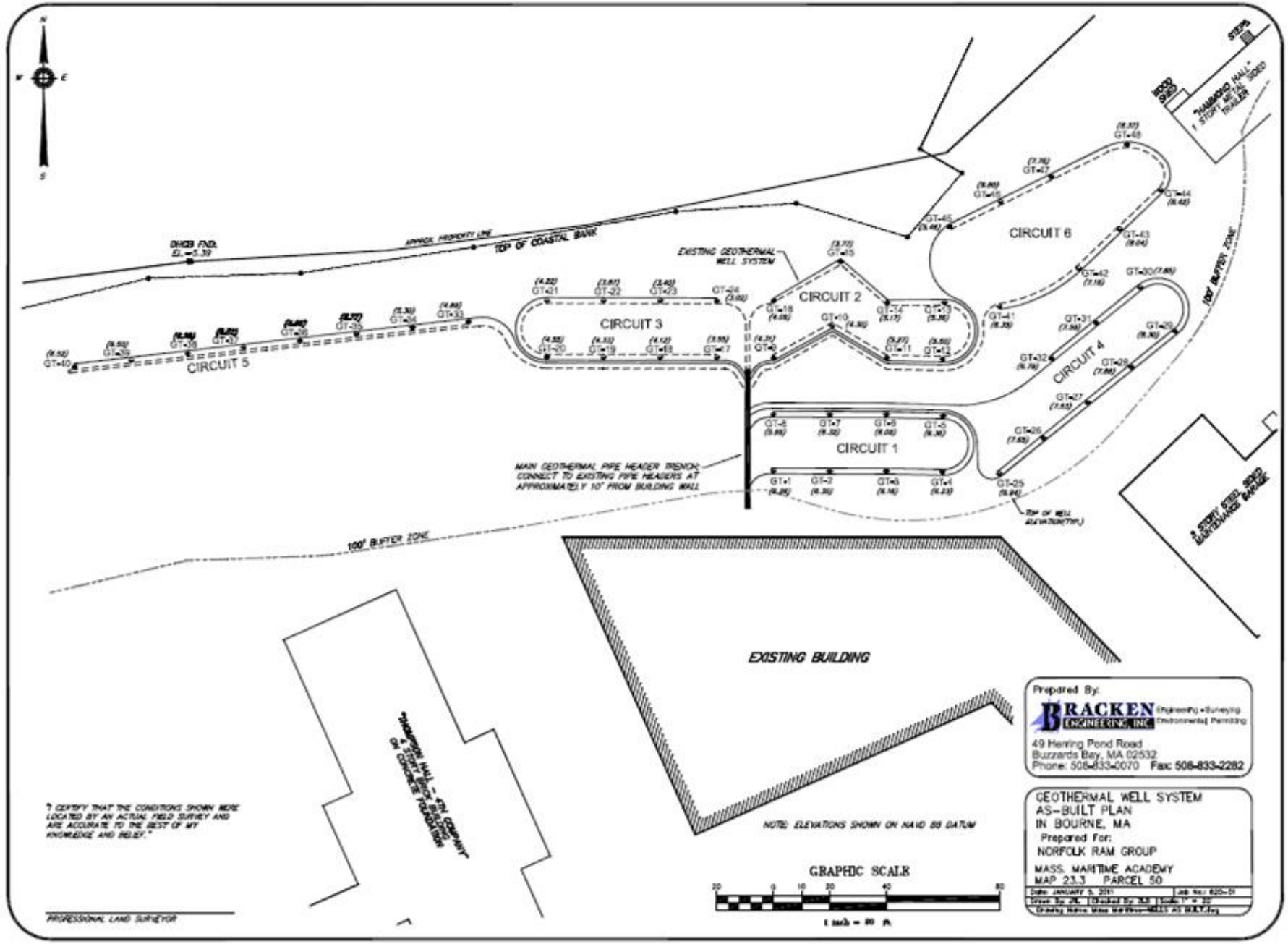
MARITIME

About

MMA Geothermal System

The ground source heat pump was installed in 2010-2011:

- Part of DCAMM library modernization project - campus resource hub
- Cost ~$800K for 48-well vertical closed-loop system at 405’
- Groundwater temperature is 54-55°F
- Provides 120 tons for heating and cooling through chilled beam distribution system
- Installed by National Geothermal


CIRCUIT 1
CIRCUIT 2
CIRCUIT 3
CIRCUIT 4
CIRCUIT 5
CIRCUIT 6
EXISTING BUILDING
EXISTING GEOTHERMAL WELL SYSTEM
MAIN GEOTHERMAL PIPE HEADER TRENCH; CONNECT TO EXISTING PIPE HEADERS AT APPROXIMATELY 10' FROM BUILDING WALL
100' BUFFER ZONE
MEAN HIGH WATER
TOP OF COASTAL BANK
NOTE: ELEVATIONS SHOWN ON NAVD 88 DATUM
GRAPHIC SCALE
1 inch = 80 ft.
I CERTIFY THAT THE CONDITIONS SHOWN WERE LOCATED BY AN ACTUAL FIELD SURVEY AND ARE ACCURATE TO THE BEST OF MY KNOWLEDGE AND BELIEF.
PROFESSIONAL LAND SURVEYOR
Prepared By:
BRACKEN ENGINEERING, INC.
49 Herring Pond Road
Buzzards Bay, MA 02532
Phone: 508-833-0070 Fax: 508-833-2282
GEOTHERMAL WELL SYSTEM
AS-BUILT PLAN
IN BOURNE, MA
Prepared For:
NORFOLK RAM GROUP
MASS. MARITIME ACADEMY
MAP 23.3 PARCEL 50

MARITIME

Lessons Learned

1. Initial sequence of operations did not conform to building conditions
    a. Worked with controls company to adjust operation of chilled water and heat pumps
    b. Identified that the building required constant cooling throughout the year and system required reconfiguration
2. Draining of glycol tank identified a leak in the system
3. Initial pumps were sized too small to properly handle the flow rate needed
4. Humidity sensors needed in the chilled beam system to avoid condensate problems

ALWAYS complete building and equipment commissioning

System Benefits

1. Dual heating and cooling allows for better building conditions and occupant comfort
    - *Can not please every occupant temperature wise*
1. Building use has increased due to its comfort and ambiance
    - *Now open until 10:00 pm weekdays*
1. Back up boiler rarely needed to supplement heating capabilities
2. No mechanical sound impacts in and around the building
3. Closed loop system requires less electricity

Next LBE Council Meeting

Save the Date!

Tentative:

Tuesday, November 9th

10:00 am–12:00 pm

Upcoming Tentative Meeting Dates:
January 11th
March 8th
May 10th

Other Key Dates

Climate Week
September 20-24
LBE 'Ask the Experts' Sessions

Peak demand

EVs and EVSE

Solar PPAs

National Drive Electric Week
September 25 – October 3

Free ride-and-drive events!

Roxbury Community College, September 25th, 10a – 2p

Lawrence Municipal Airport October 2nd, 2p – 6p

Holyoke Veterans' Memorial Park, October 6th, 4p – 6p