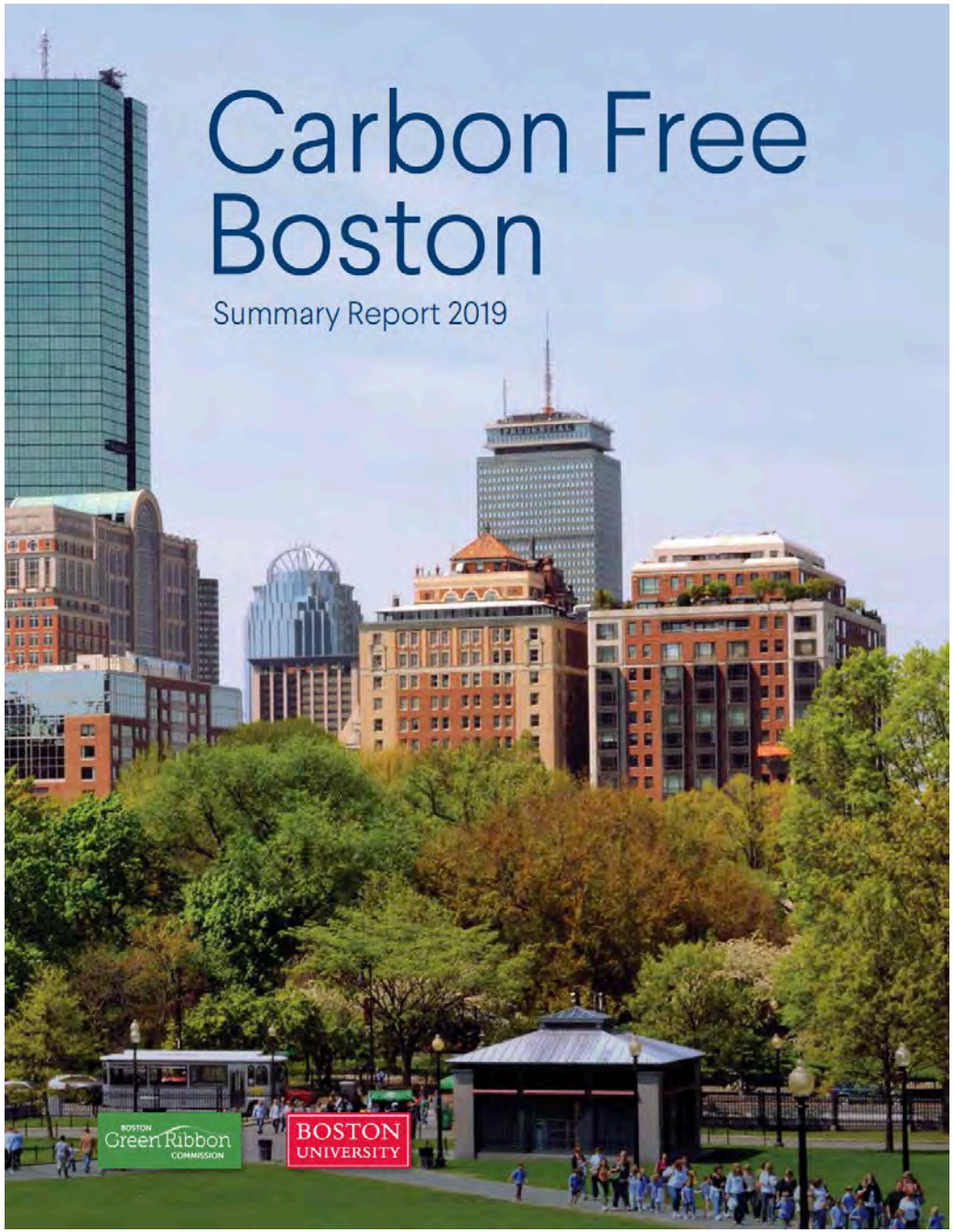
Carbon Free Boston

Summary Report 2019



People and Process

Expert Advisory Groups

- Buildings
- Transportation
- Waste
- Energy
- Social Equity

Steering Committee

Other organizations

Boston University Institute for Sustainable Energy

- Technical and Support Staff
- Consultants

Carbon Free Boston Report

Green Ribbon Commission

City of Boston

Funders and CFB Working Group

CFB Working Group

Mindy Lubber, Ceres (Chair)

Robert Brown, Boston University

Bill Fahey, Veolia

Joe Grimaldi, Mullen Lowe

Amos Hostetter, Barr Foundation

Katie Lapp, Harvard

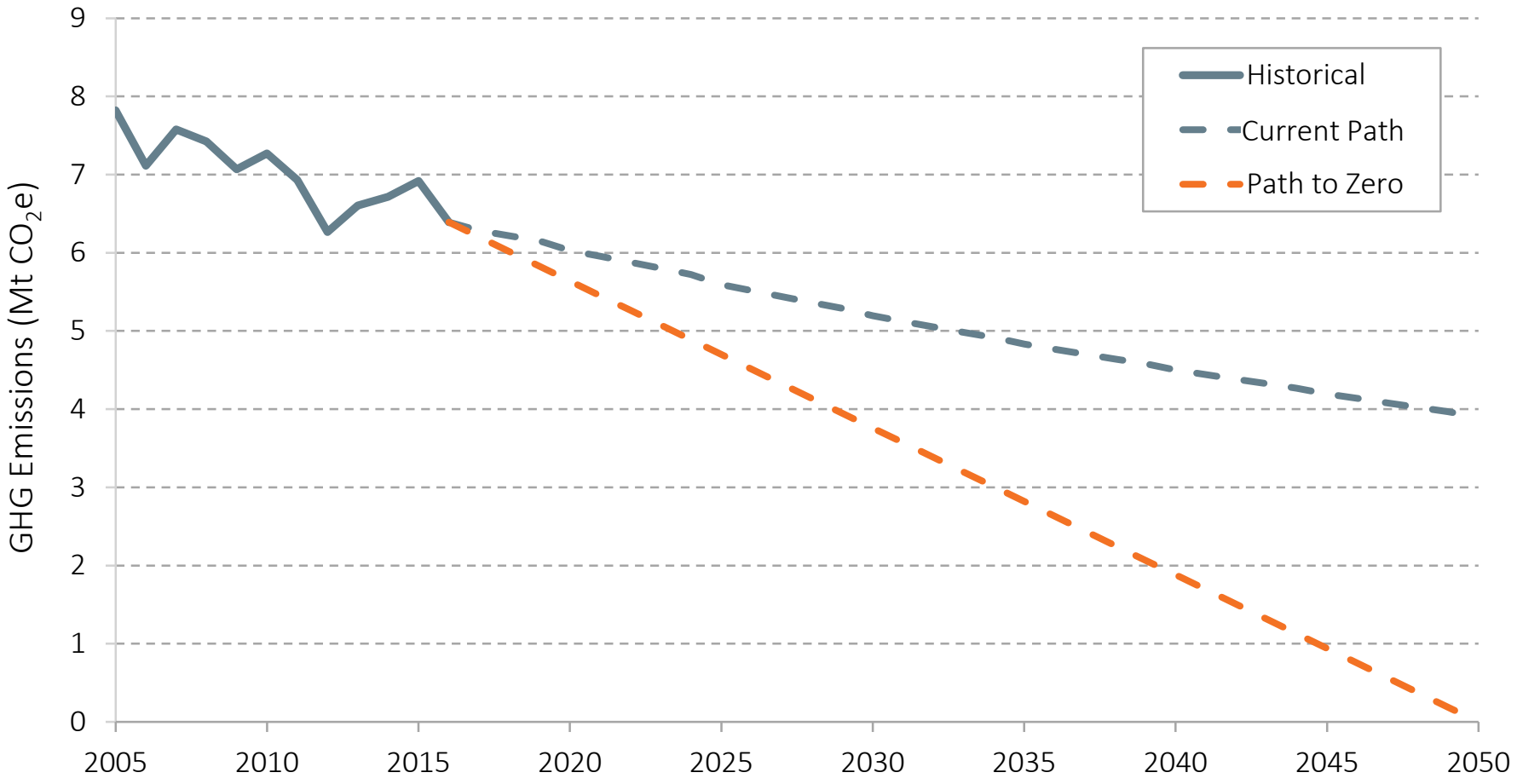
Alex Liftman, Bank of America

Penni Mclean-Conner, Eversource

Marcy Reed, National Grid

Israel Ruiz, MIT

Carbon Neutrality Requires Decisive Action



Four Mutually Reinforcing Strategies Must Be Pursued Together

Reduce demand for energy and maximize energy efficiency

Electrify all activity to maximum extent feasible

Use GHG-free fuels and electricity

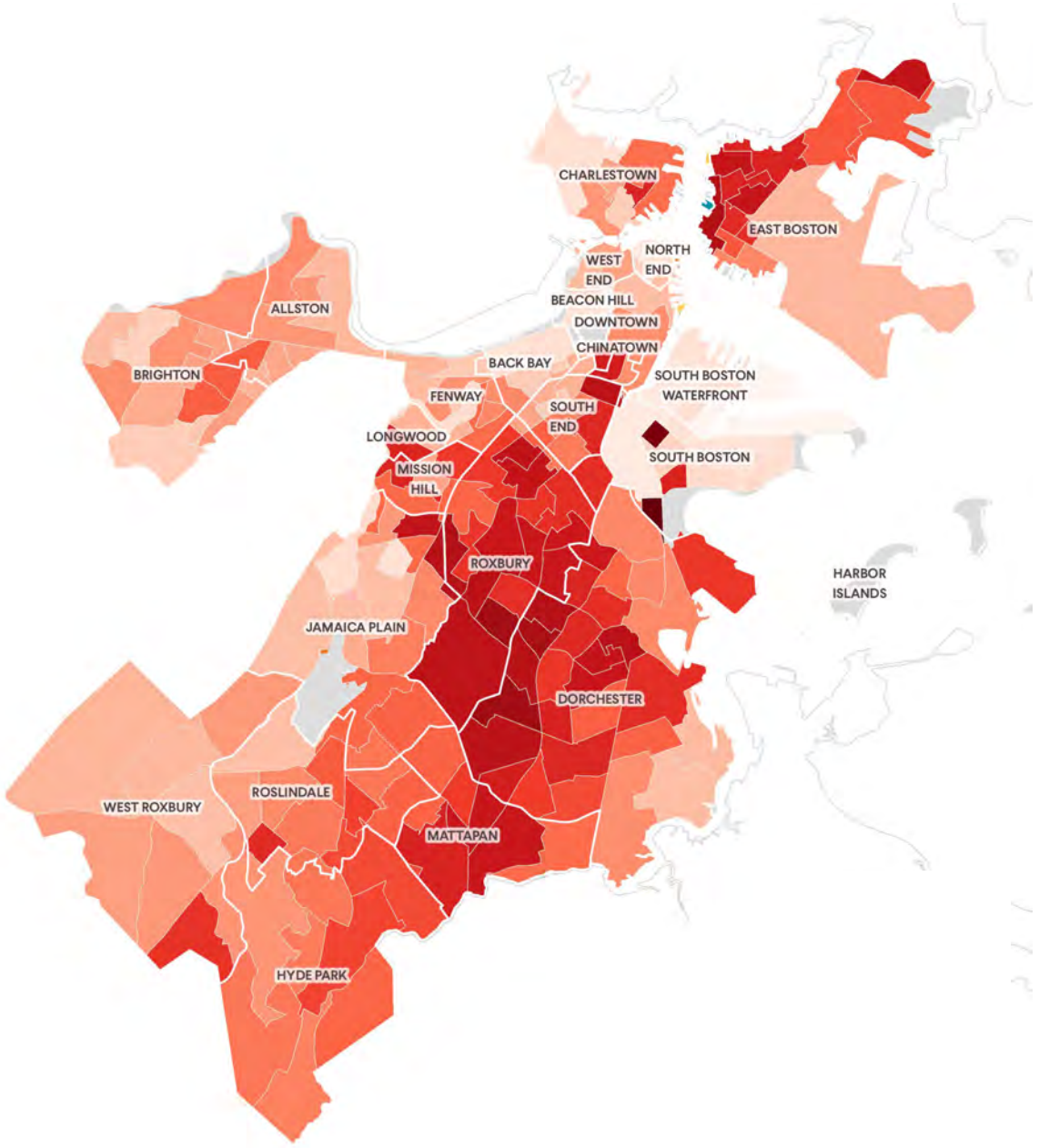
Improve social outcomes via intentional action

How You Do It Matters

Every decision has tradeoffs:

- Public health
- Social equity
- Resilience
- Jobs and economic opportunity
- Capital and operating expenses
- Political and technological dependencies (phasing)

Socially Vulnerable Populations in Boston



Dimensions of Energy Insecurity

Physical:

- Malfunctioning HVAC and appliances, poor lighting, drafts

Economic:

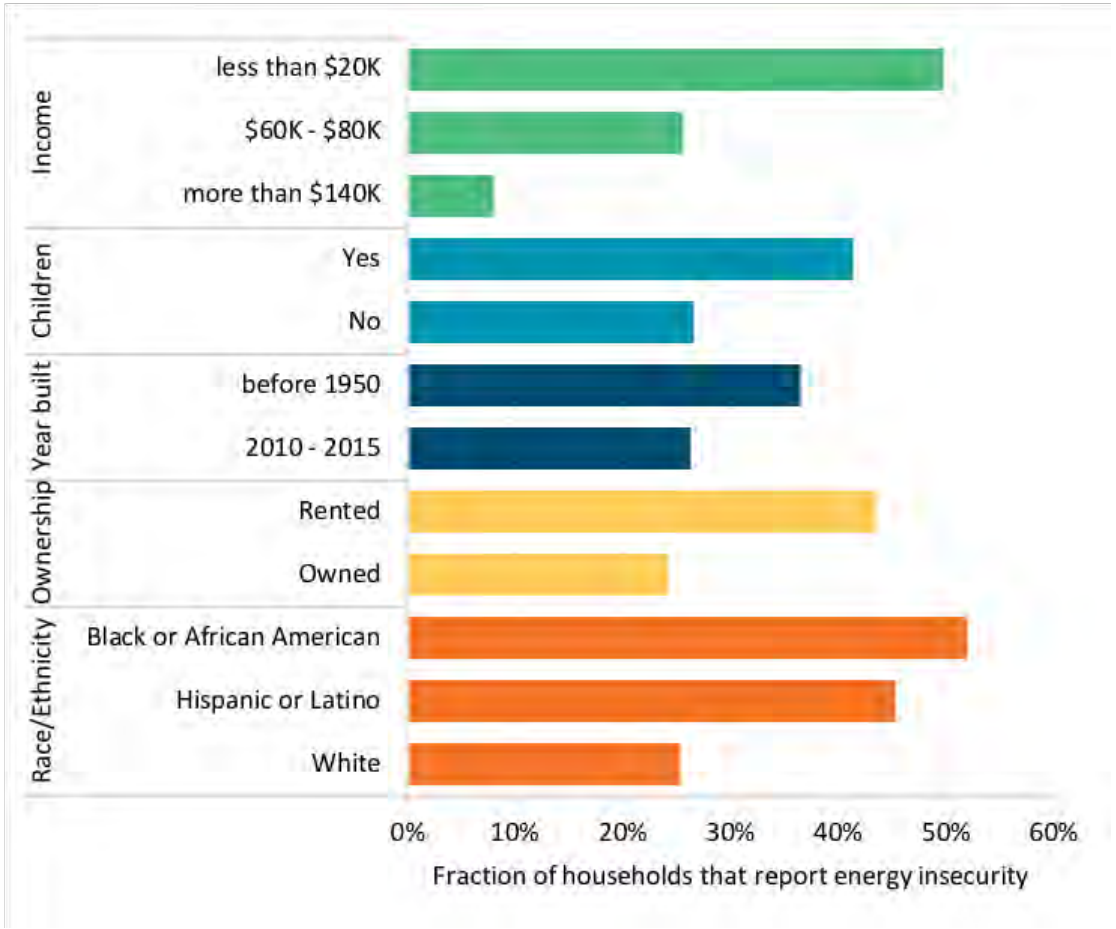
- Cost of fuel and electricity

Behavioral:

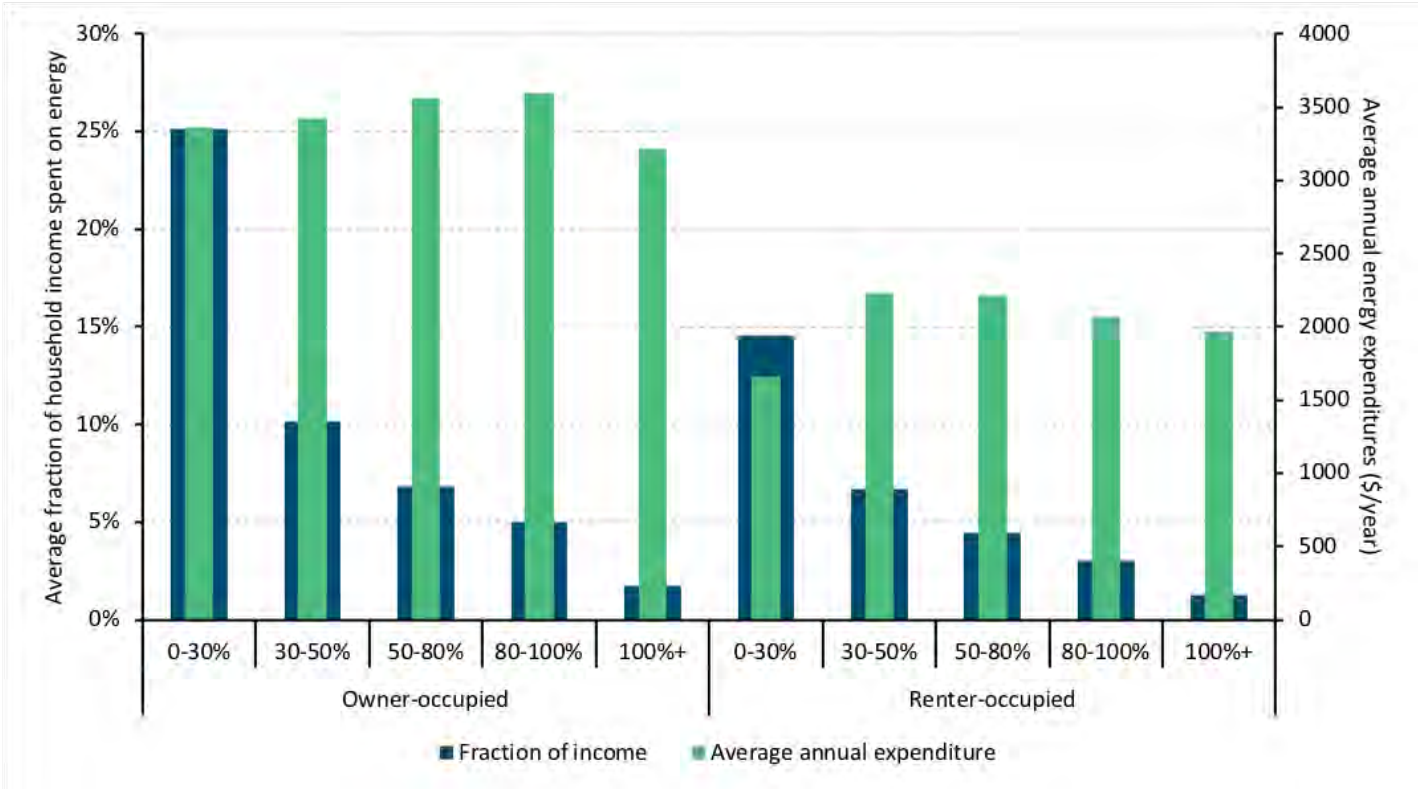
- Budget tradeoffs that jeopardize health: “heat or eat”
- Use of dangerous alternatives (ovens, space heaters)
- Unpaid bills, arrearages, disconnections, housing instability

Robbin Taylor, Resident of Dorchester, MA (Credit: Martha Bebinger/WBUR)

Economic Burden of Energy Insecurity in U.S.



Economic Burden of Energy Insecurity in Boston



Dimensions of Transportation Insecurity

Access:

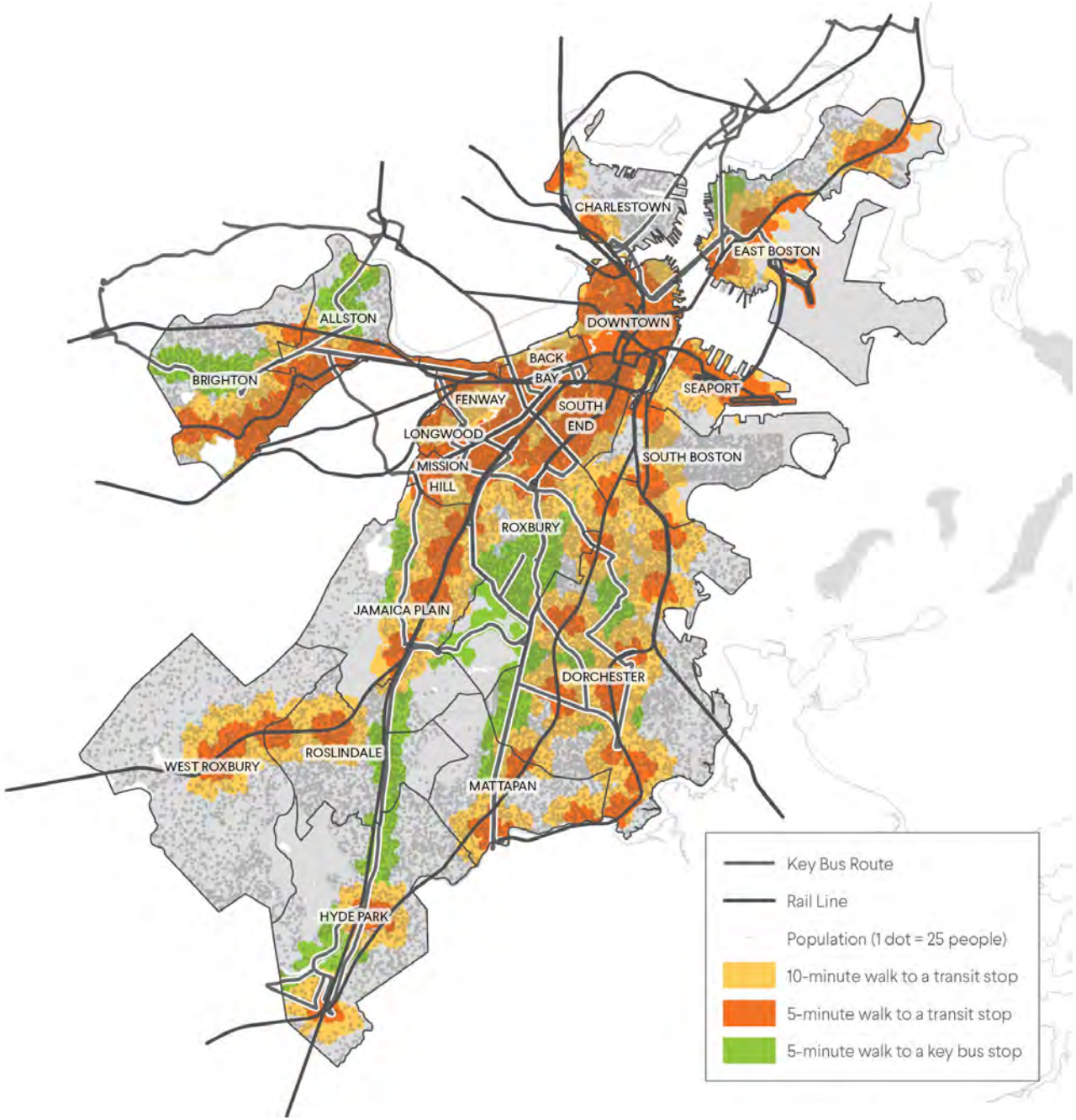
- Public transportation
- Biking
- Ride-hailing
- EV charging

Cost:

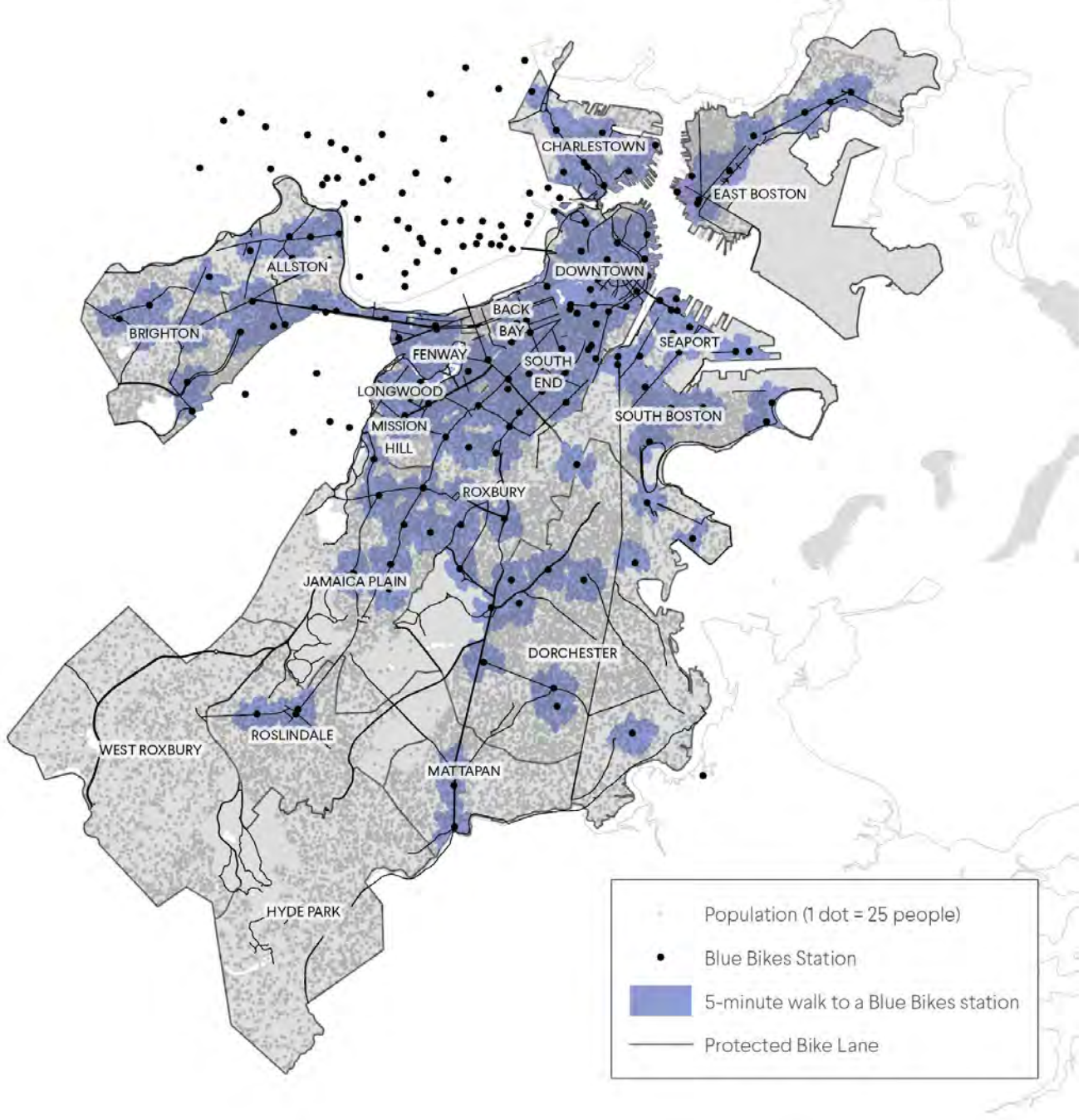
- Commute time

Rosa Parks in the front of a city bus in Montgomery, Ala., in 1956. *Credit*: UPI

Access to Public Transportation



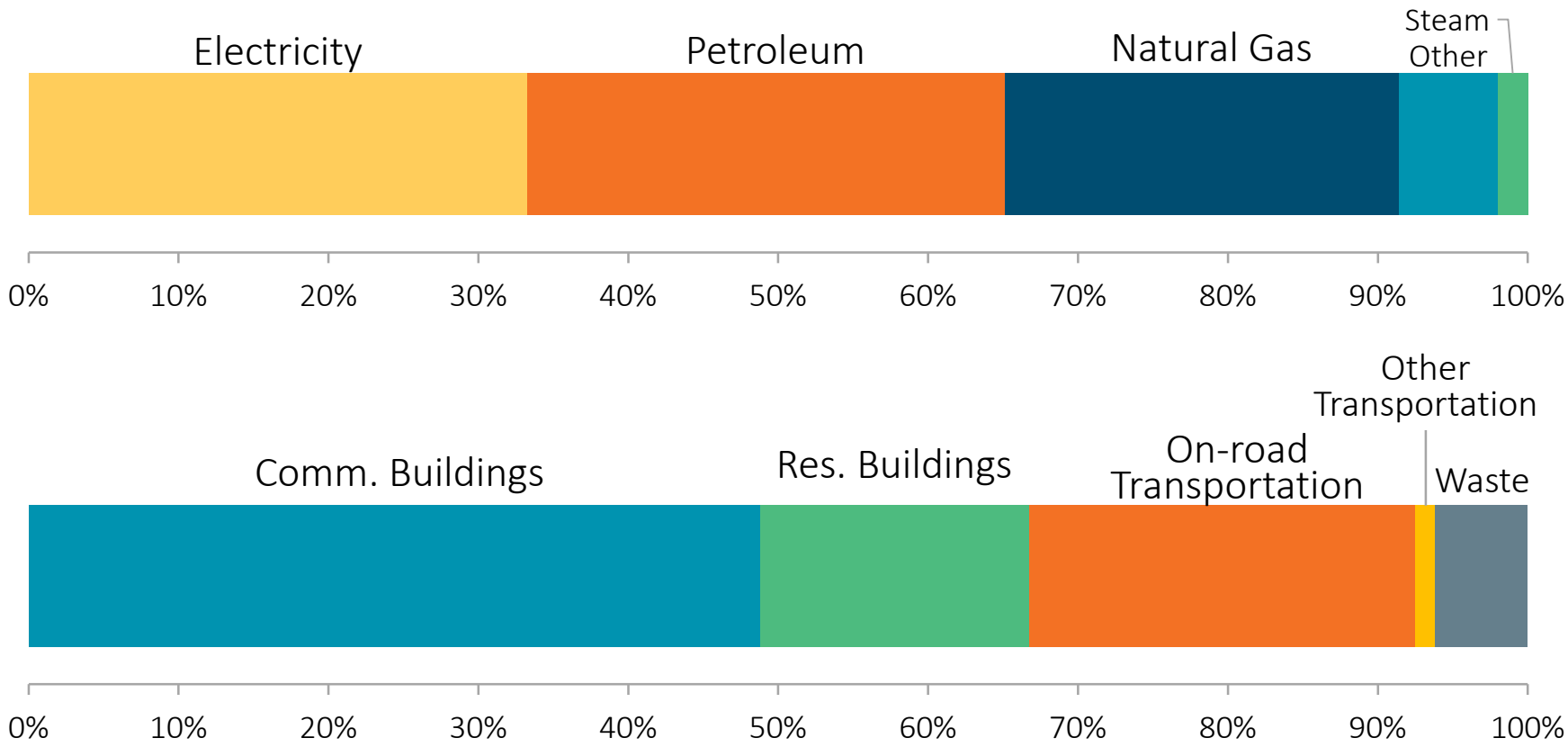
Access to Biking



Social Equity Framework

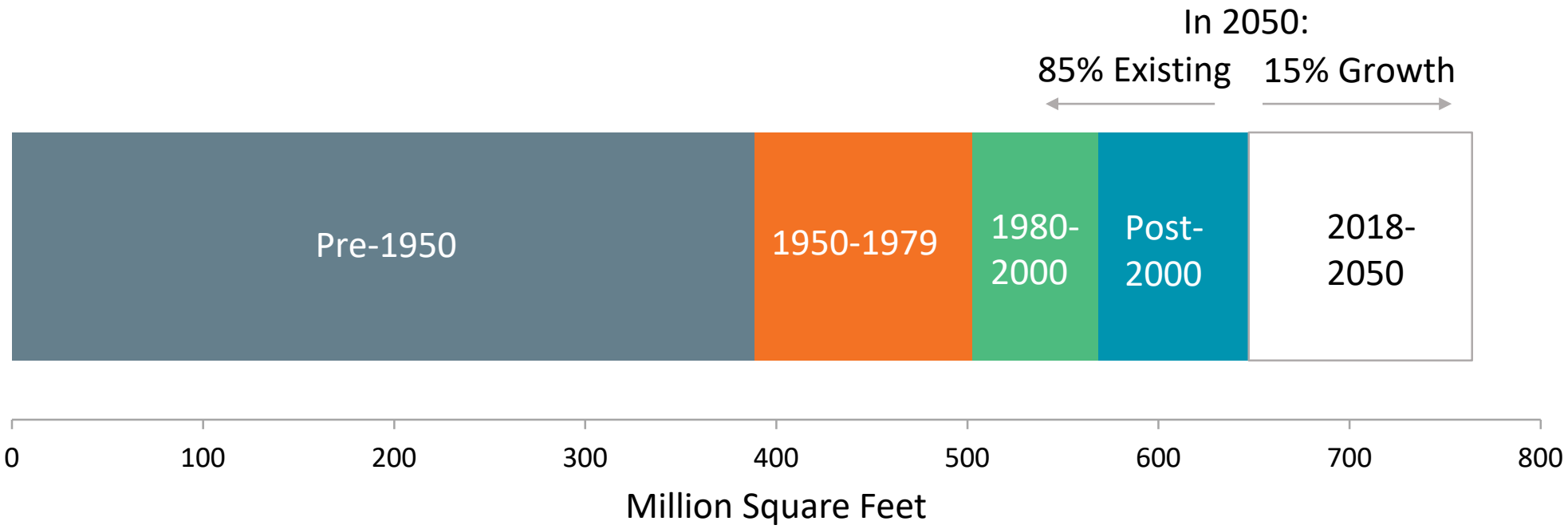
Components	Evaluation	
Is it green?		
Is it GHG-free?	Reduces GHG emissions: electrification, active transport, lower non-CO_2 emissions	Yes / No / Depends
Is it environmentally sustainable?	Less energy used or fewer GHGs emitted to provide the same energy service; other environmental considerations: land and water use, pollution, etc.	Yes / No / Depends
Does it promote smart behavior?	Use or behavior is altered in ways that accomplish more than GHG reductions: i.e., better timing or siting for congested resources, smarter use of resources, waste reduction	Yes / No / Depends
Is it fair?		
Is it accessible?	Available to and beneficial for all communities; addresses historical disparities and cultural differences	Yes / No / Depends
Is it affordable?	All private residents can afford it; limits negative impacts on public sector	Yes / No / Depends
Are workforce opportunities just?	Fairness and balance in workforce and contractor diversity; addresses historical disparities	Yes / No / Depends
Who gets to decide?		
Is it inclusive?	Impacted and/or socially vulnerable communities have an active and meaningful role in decision-making	Yes / No / Depends
Are values considered?	Decision-making processes go beyond dollars and cents to address shared values and cultural differences	Yes / No / Depends
Is it measurable?	Quantity and quality of service provided and community impacts can be measured quickly and continually in order to provide important performance feedback	Yes / No / Depends

Fossil Fuels Dominate GHG Emissions in 2016



Buildings

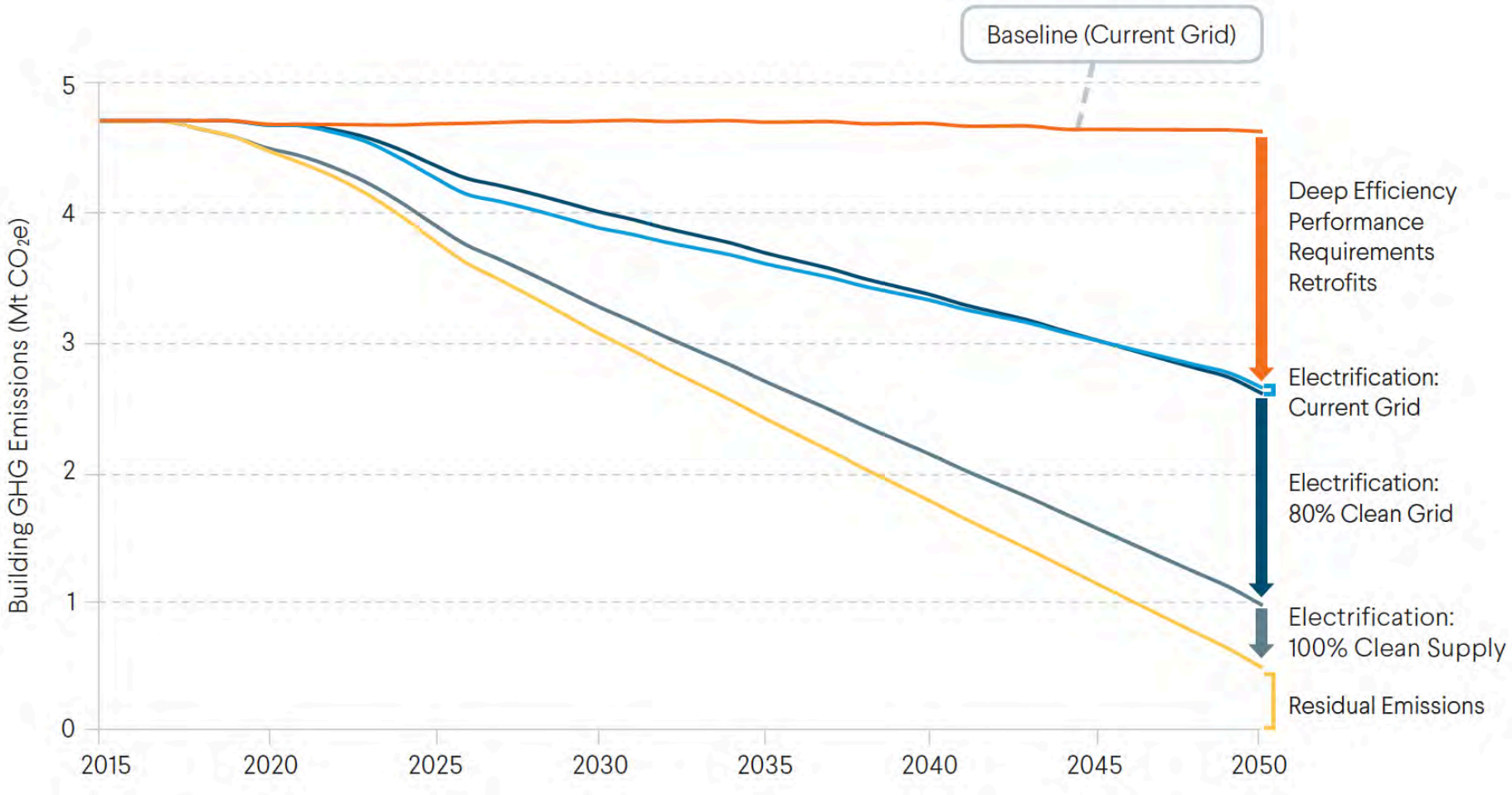
Boston's Building Stock is Old, Diverse, and Inefficient



Summary of Building Options

Strategy	Policy Mechanisms
Thermal Electrification	Incentives and/or mandates
Energy Conservation Measures	Incentives
Performance Requirements	BERDO Expansion
Deep Energy Retrofits	Requirement with sale or major renovation
Low Energy New Construction	Code / Planning Requirements

Path to Carbon-Neutrality in Buildings



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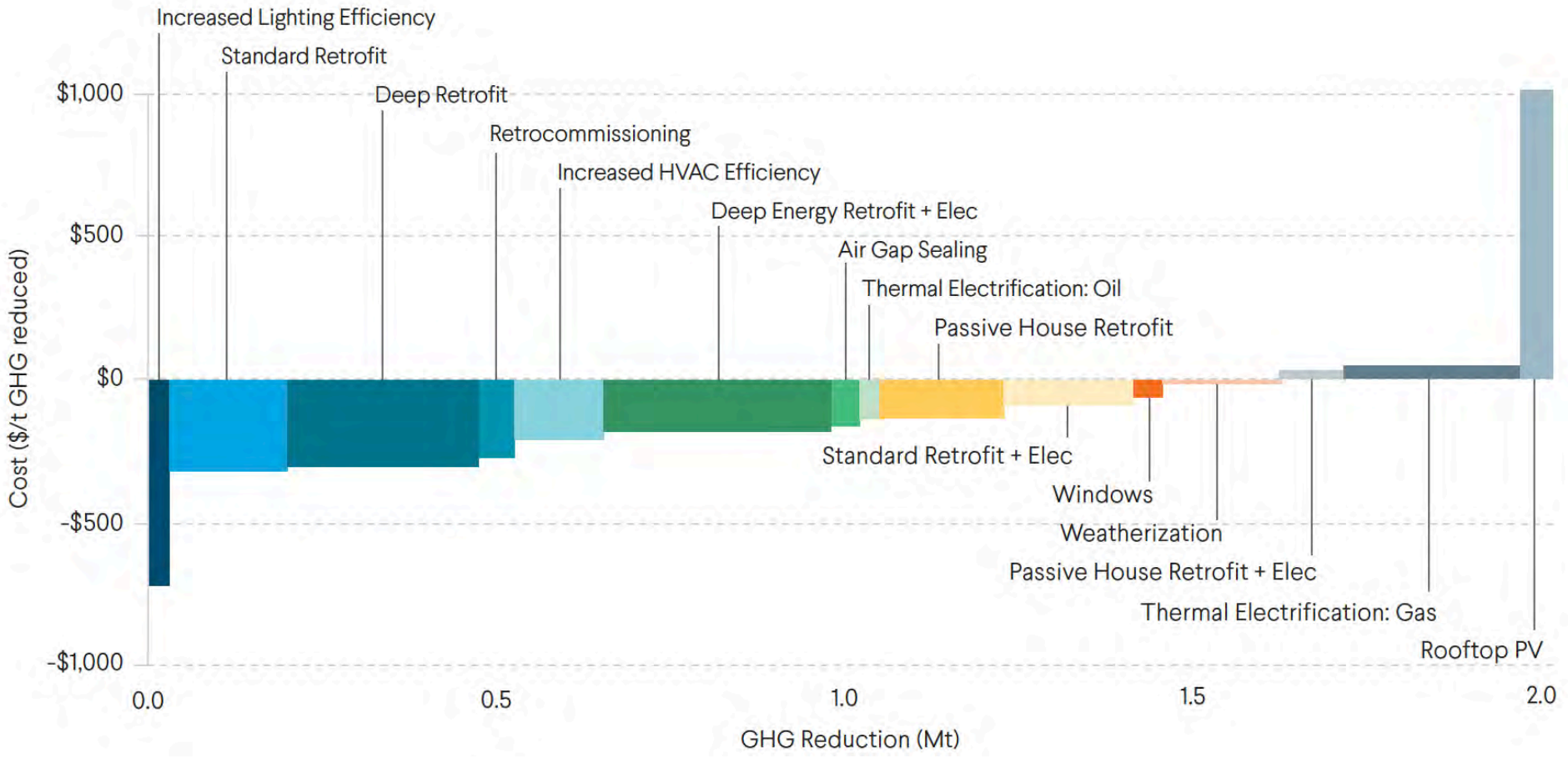
The Cost of GHG Reduction in Buildings



Cutting Emissions Improves Health, Affordability, and Equity

Benefits

75% reduction in harmful air pollution in 2050 • minority HHs benefit the most
$600 million in energy cost savings in 2050 • reduced energy burden for poor and minority HHs
Health benefits from improved indoor air quality
Economic stimulus (disposable income, jobs, asset value)
Enhanced climate resiliency

Equity Scorecard: Deep Retrofits

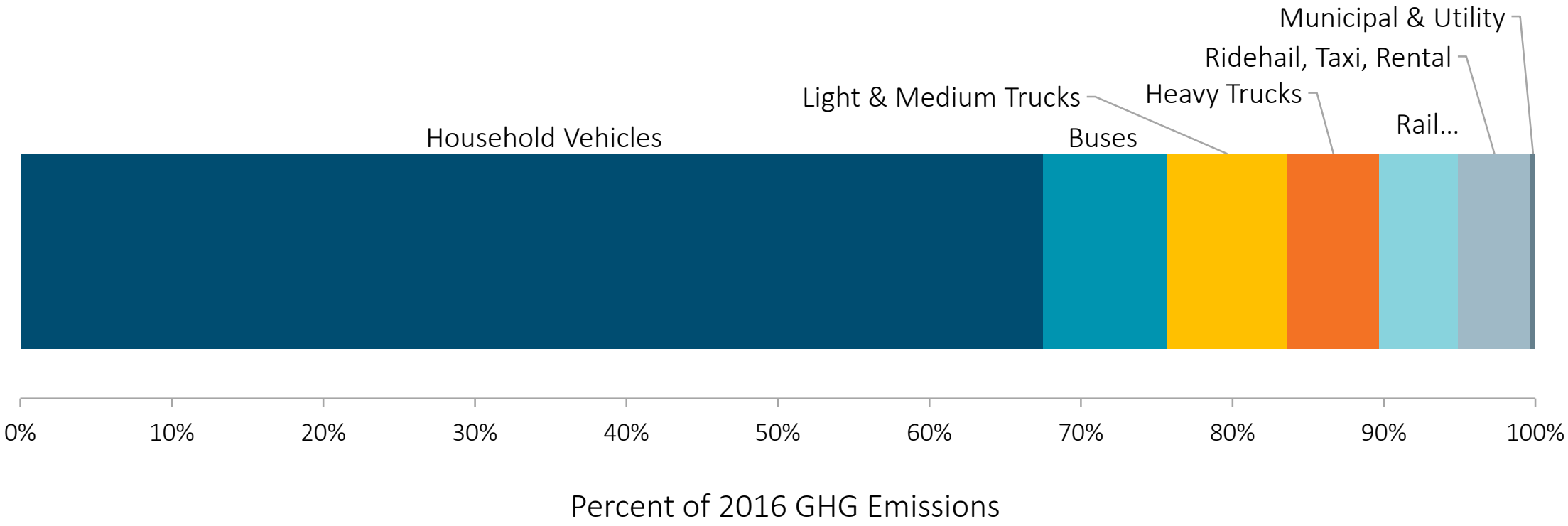
Components	Evaluation
Is it green?	
GHG-free?	Depends: requires GHG-free electricity and fuels
Environmentally sustainable?	Yes
Smart?	Depends: grid integration, shave peak demand, more occupant control of space
Is it fair?	
Accessible?	Depends: communication strategy must be geared to broad audience
Affordable?	Depends: upfront capital costs
Workforce opportunities just?	Depends: intentional policy design
Who decides?	
Inclusive?	Depends: intentional planning must include renters as well as owners
Values considered?	Depends: intentional policy design
Measurable?	Depends: energy use, boilers replaced, and $ easy to measure; community and workforce impacts more difficult

Bottom Line: Building Sector Requires Electrification with Retrofits at a Large Scale

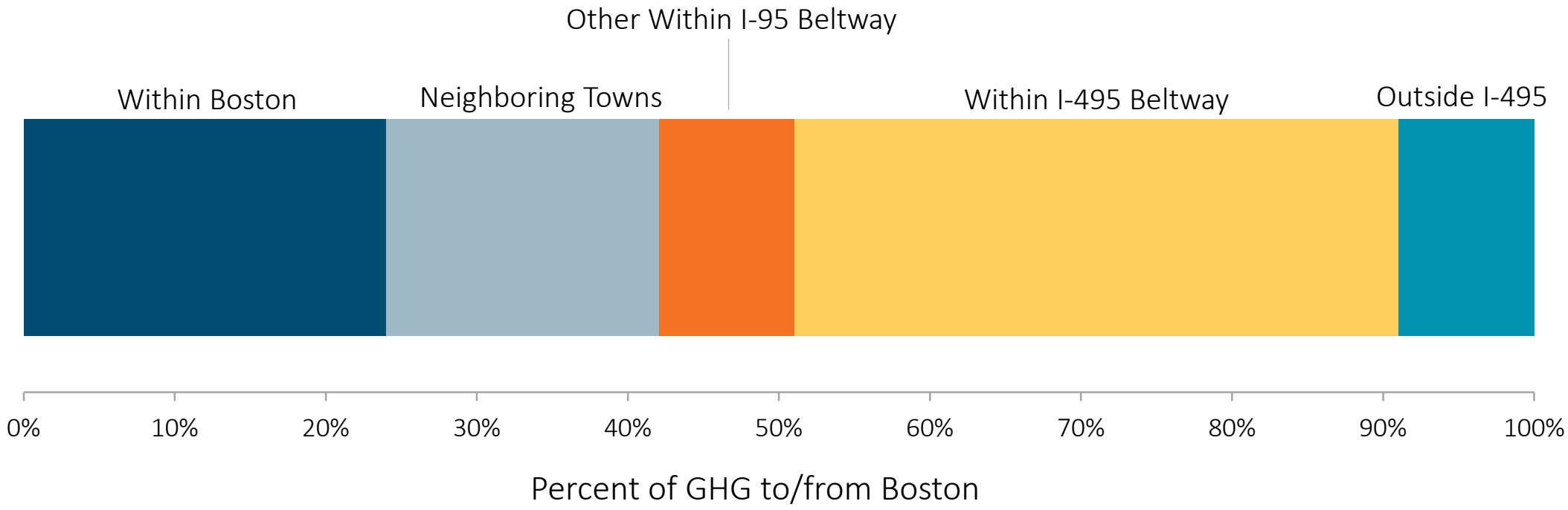
- Most measures save money
- Energy efficiency can reduce energy insecurity through intentional design
- Nearly all buildings will require significant retrofits and thermal electrification
- Retrofits must reduce energy use and convert gas & oil to electricity
- Energy retrofits can be integrated with resiliency retrofits

Transportation

Personal Vehicles Drive GHG Emissions



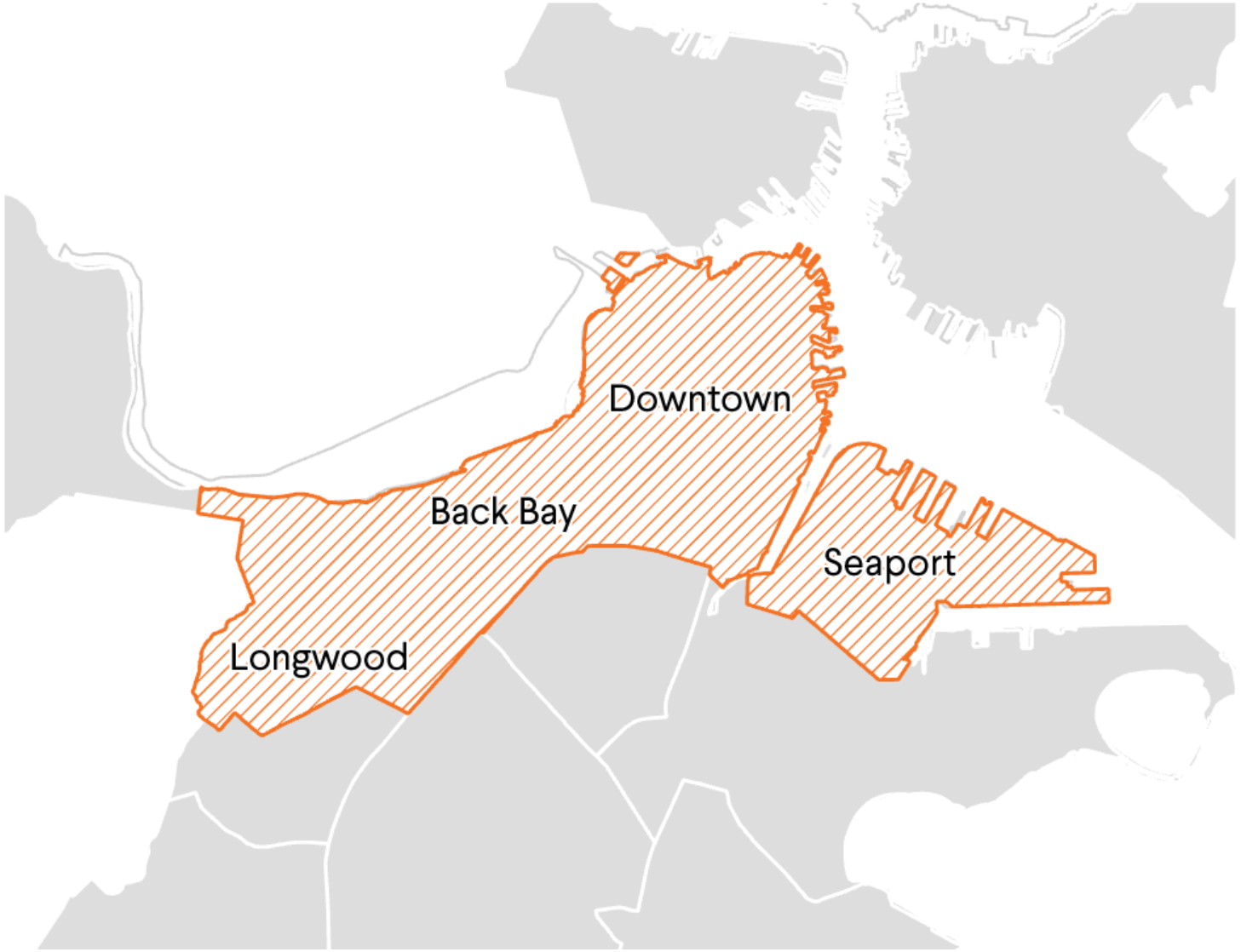
Long Trips Drive GHG Emissions



Summary of Transportation Options

Strategy		Policy Mechanisms
MODE SHIFT	Improved Transit	▪ 100% electric ▪ Expanded BRT & rail
	Free/reduced cost transit	▪ Free for walk-access transit ▪ 50% reduction for drive-access
	Walking & Biking	▪ Citywide bike lane & walking improvements
	Trip Pricing	▪ Cordon/Congestion Fee ▪ Parking Fee ▪ VMT Fee
	Shared mobility	▪ Fee for ride alone ▪ Subsidy for pooled ride
AUTONOMY	Connected Autonomous Vehicles	▪ Requires regulatory framework
ELECTRIFICATION	Electric Vehicles	▪ Drive market transformation ▪ Create infrastructure ▪ Prohibit fossil fuel vehicles

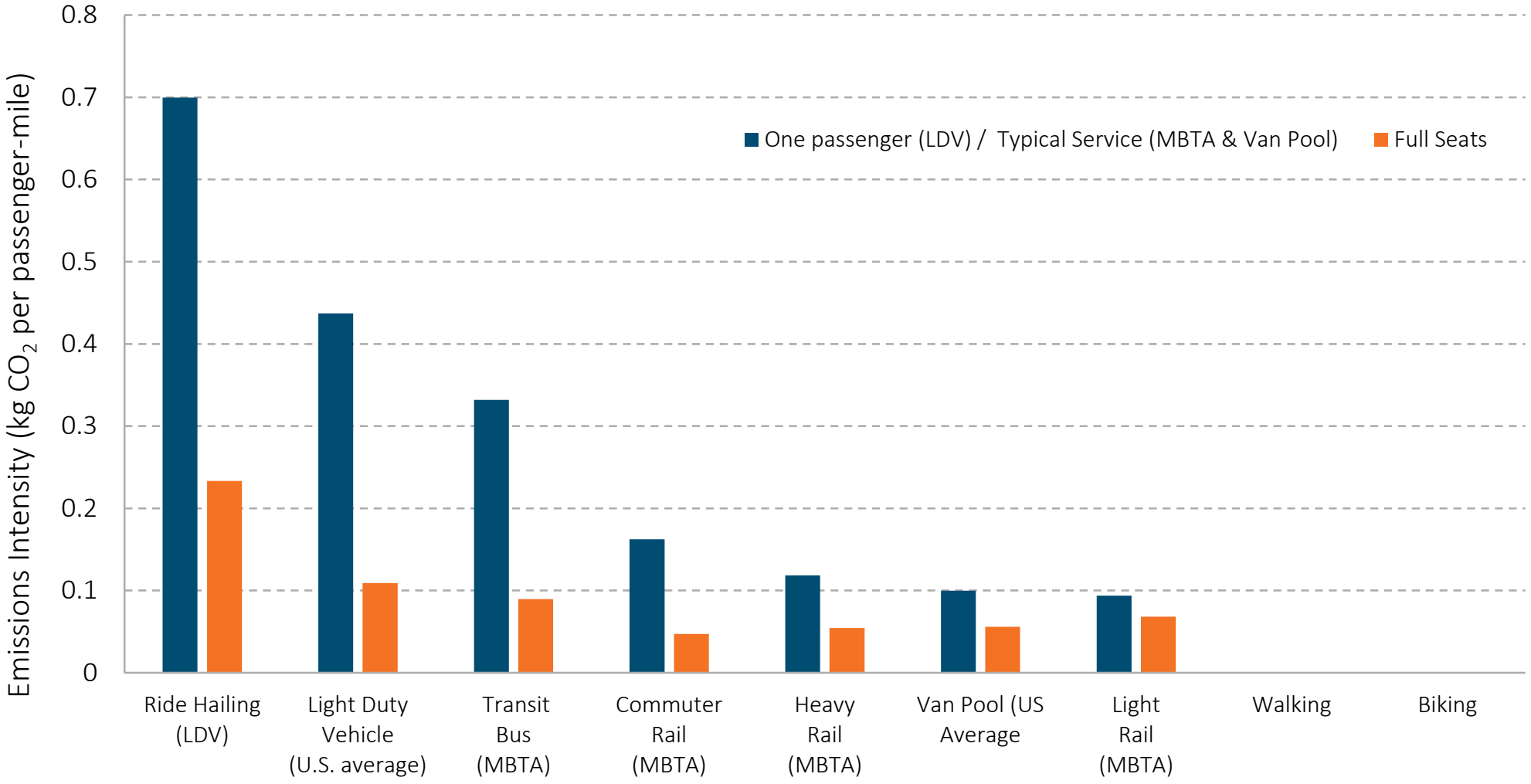
Congestion Zone



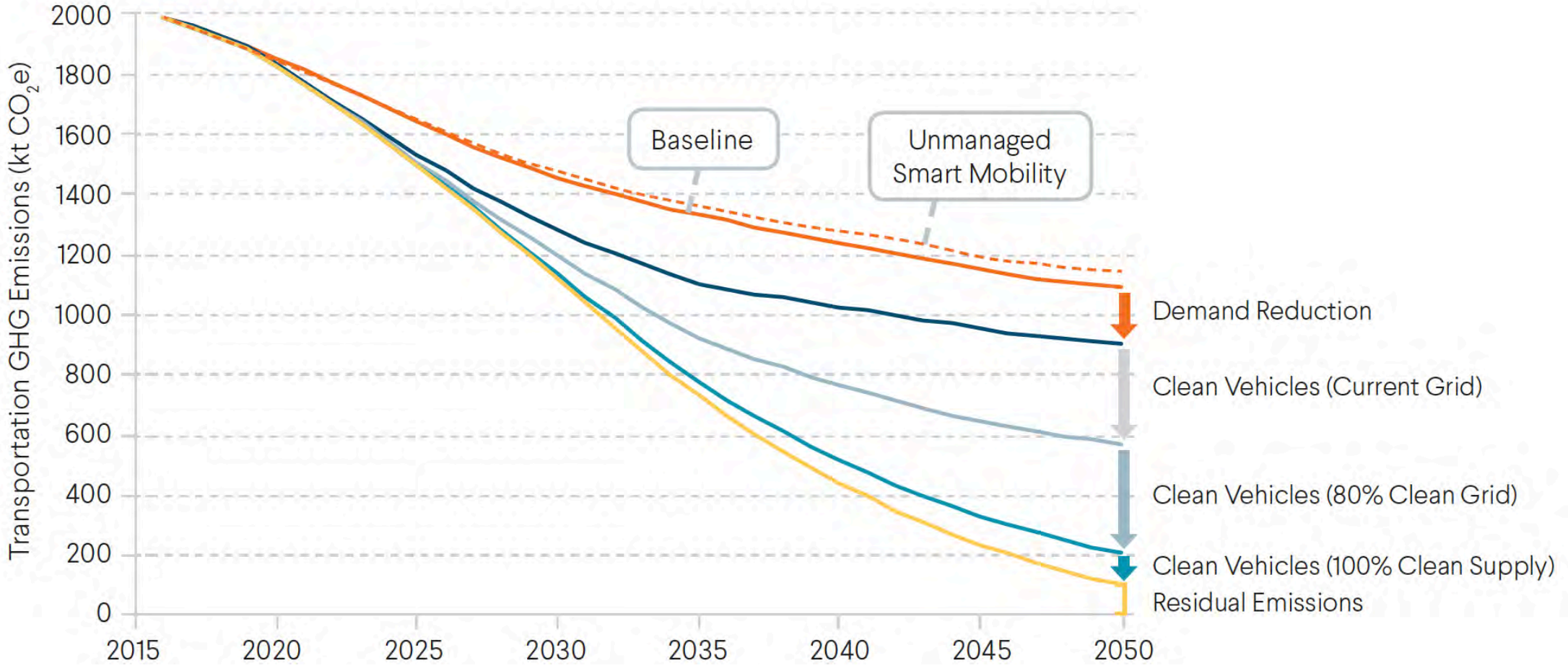
Daily Person Trips Made in Boston in 2050

Mode	Baseline	Pathway to 2050 Scenario	Percentage change
Private Vehicles	2,010,145	853,748	-58%
Shared Mobility	79,899	884,065	+1006%
Transit	470,680	672,406	+43%
Walking + Biking	973,448	1,079,763	+11%
Total Person Trips	3,534,172	3,489,983	-1%
Cumulative VMT to/from Boston			-33%
Auto ownership in Boston			-45%
Auto ownership outside Boston			-30%

GHG Intensity of Travel



Path to Carbon-Neutral Transportation



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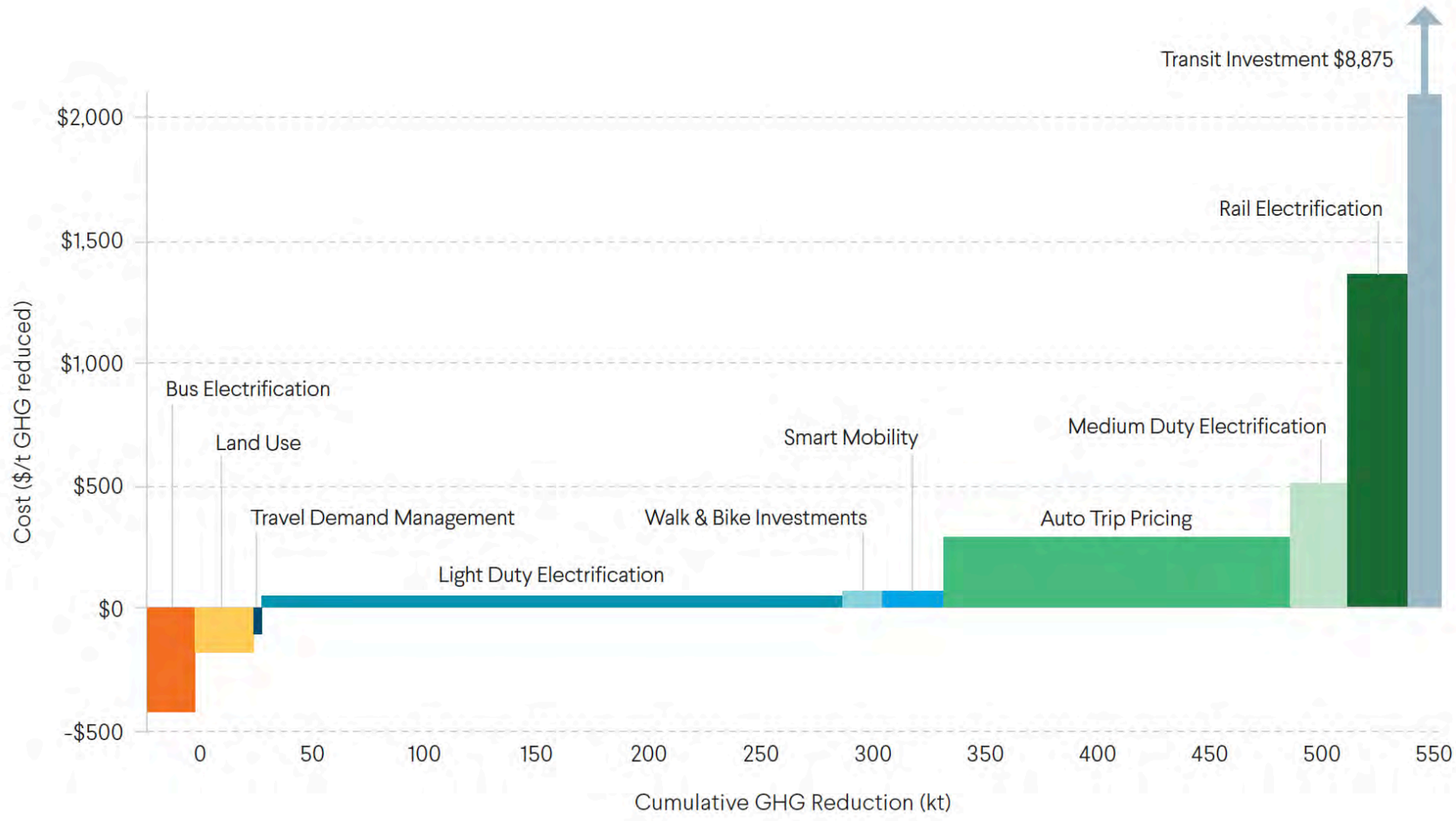
Cost of GHG Reduction in Transportation



Benefits of Carbon-Neutral Transportation

Benefits in 2050

Access and cost inequities can be eliminated through intentional design

$ 259 million reduction in motor vehicle crash costs

29% to 55% reduction in harmful air pollutants; minorities disproportionately benefit

$ 8 million health care savings from air quality improvements; minorities disproportionately benefit

$ 52 million in health care savings from increased physical activity

$ 414 in vehicle operation cost savings

Equity Scorecard: EVs

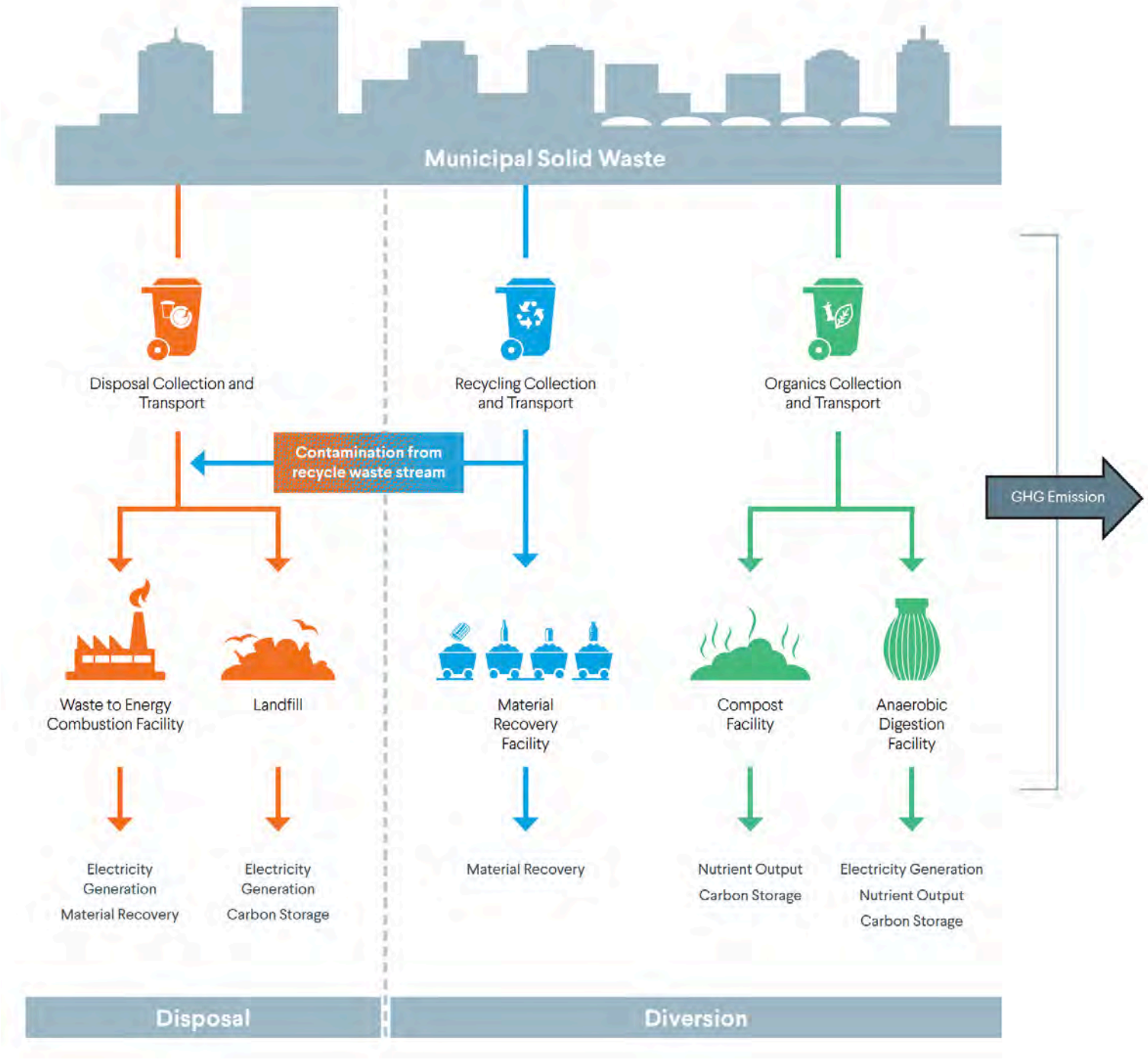
Components	Evaluation
Is it green?	
GHG-free?	Depends: requires GHG-free electricity
Environmentally sustainable?	Yes
Smart?	Depends: timing of charging; location of charging
Is it fair?	
Accessible?	Depends: access to charging
Affordable?	Depends: EV purchase price higher, operating cost lower
Workforce opportunities just?	Depends on policy design
Who decides?	
Inclusive?	Depends: intentional planning with involvement beyond owners and drivers
Values considered?	Depends: intentional planning
Measurable?	Depends: cars, charges, and $ easy to measure; community and workforce impacts more difficult

Bottom Line: Transit, Active Transport, and Clean EVs Must be Pursued Together

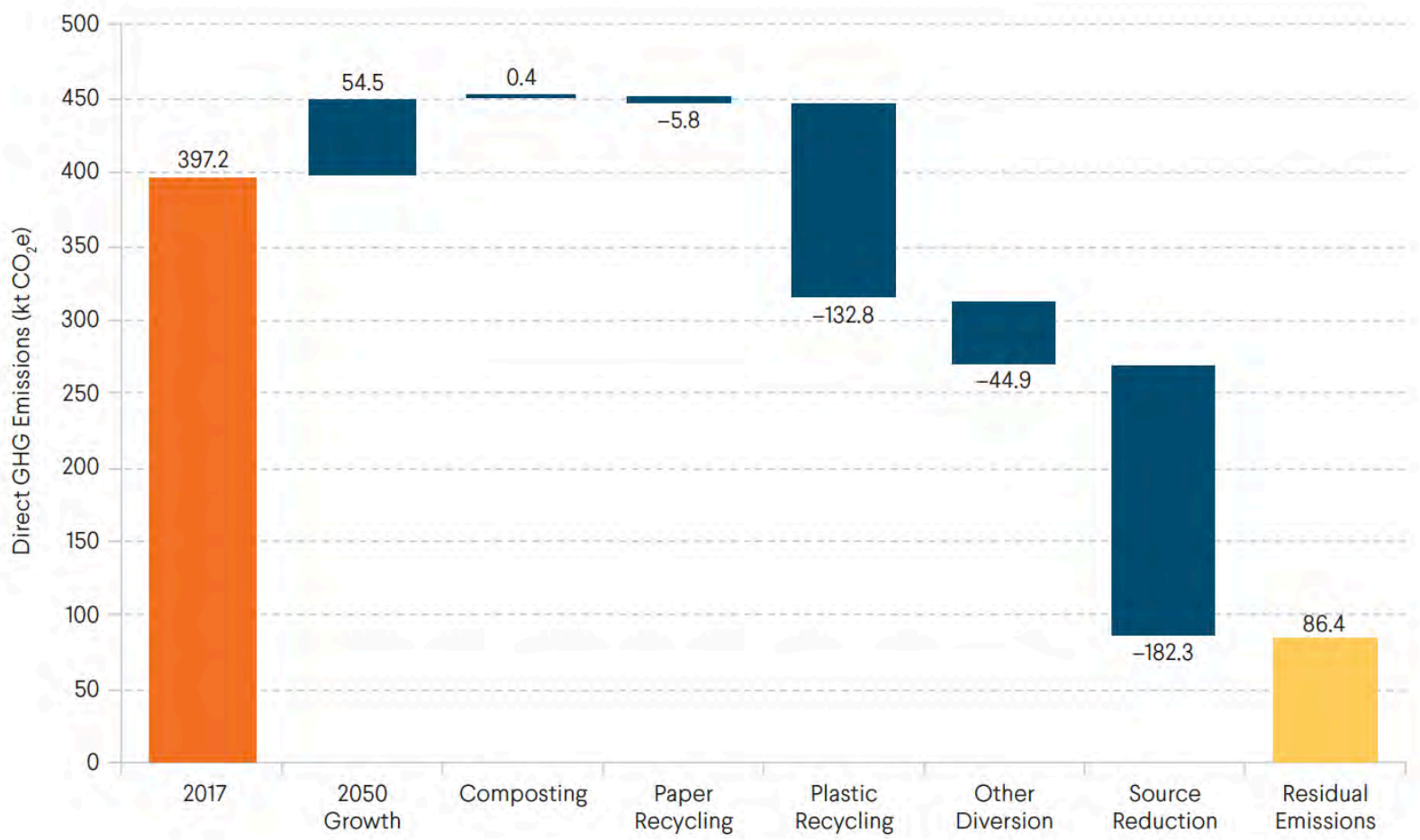
- Moving people to transit, walking, and biking provide modest GHG reductions, but large social benefits (congestion, access, health)
- Carbon neutrality requires a near 100% conversion of light and medium vehicles to electricity
- Electrification has important tradeoffs: equity, use of curbside space, etc.

Waste

MSW Waste Flows



Path to Carbon-Neutral Waste



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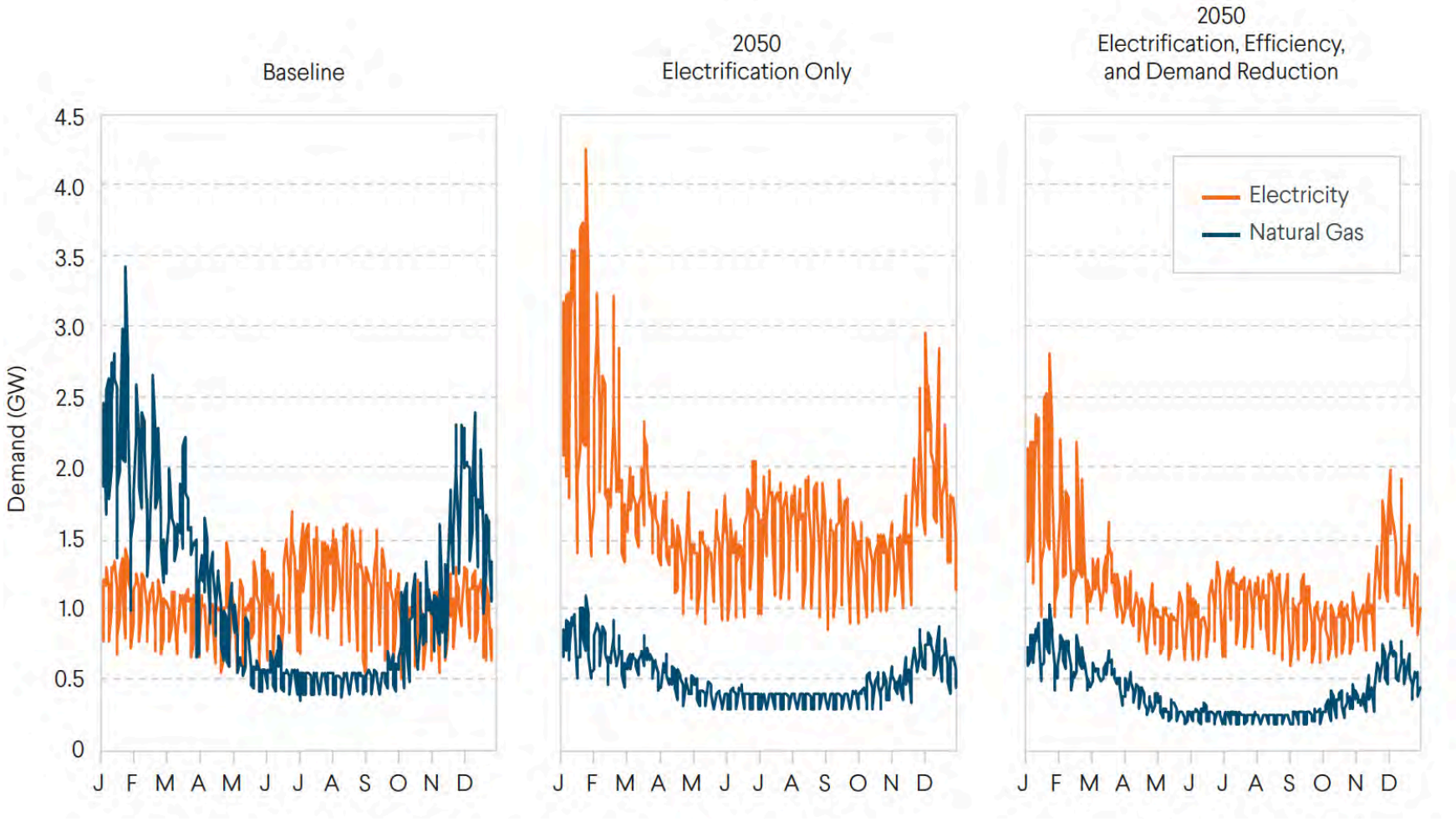
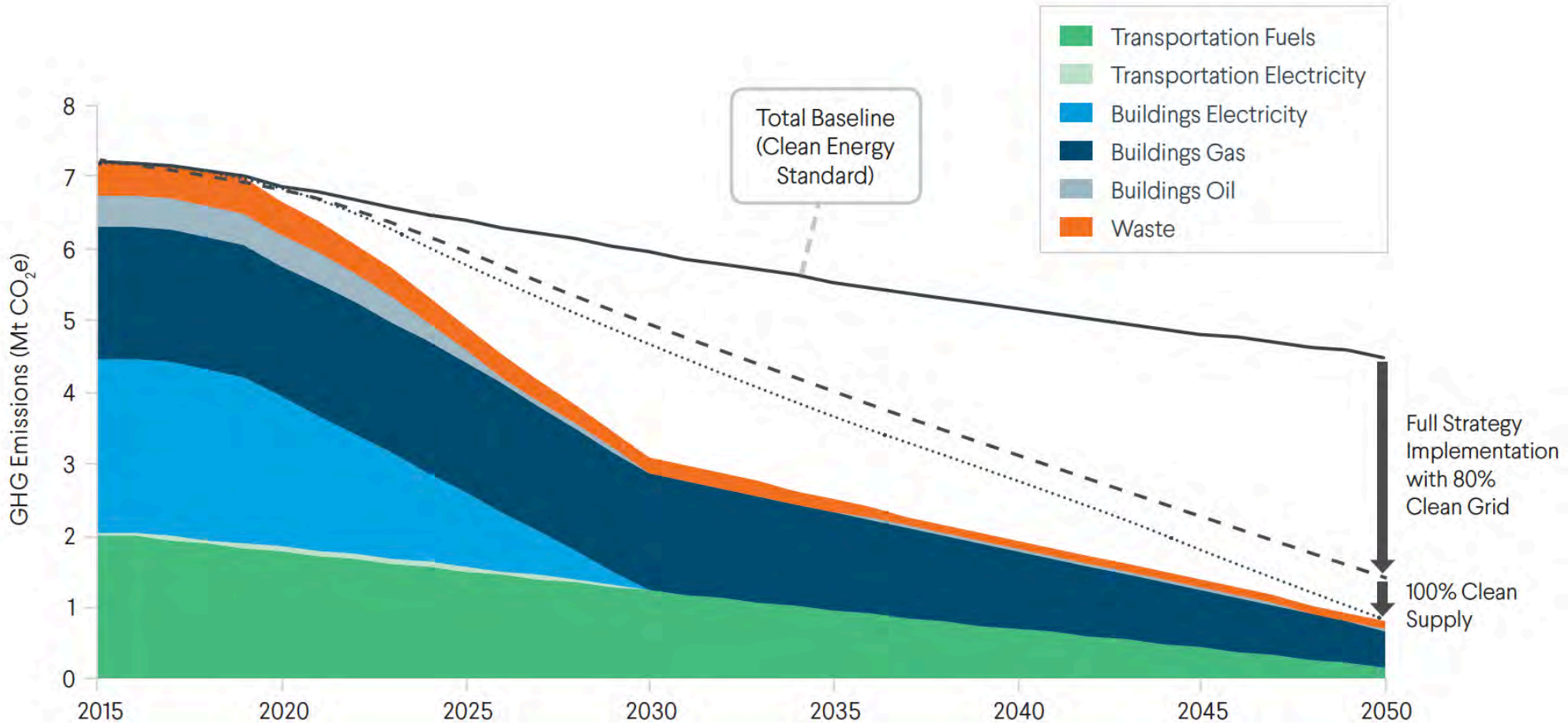
Energy Supply

Efficiency and Electrification Reduce Demand and Change Load Profile



Boston's Path to Carbon-Neutrality



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