

# Building Performance Standards & their impact to projects in design

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**nbbj** | Design  
Performance

# Outline

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- What are building performance standards?
- Impact on design decision making
- Impact on the energy design process



# What are building performance standards?

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Leaders across the U.S are exploring **building performance standards (BPS)** to reduce building energy use and carbon emissions.

A BPS requires buildings to meet carbon and energy performance targets by specific deadlines.

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**More than 600** local U.S. governments have climate action plans that include greenhouse gas (GHG) reduction targets

Reaching these goals will require addressing energy use in **new and existing buildings**



30%

Nationwide, buildings  
account for **almost a  
third** of annual GHG  
emissions



In many cities, building  
contribute to an even  
larger percentage of  
GHG emissions

**74%**  
Salt Lake City

United States **58%**  
Columbus

**70%**  
New York City

**41%**  
Los Angeles

**80%**  
St. Louis

**64%**  
Atlanta

**32%**  
Commercial  
and  
Industrial  
Buildings

**24%**  
Residential  
Buildings

**19%**  
Institutional  
and  
Government  
Buildings

**19%**  
Passenger  
Vehicles

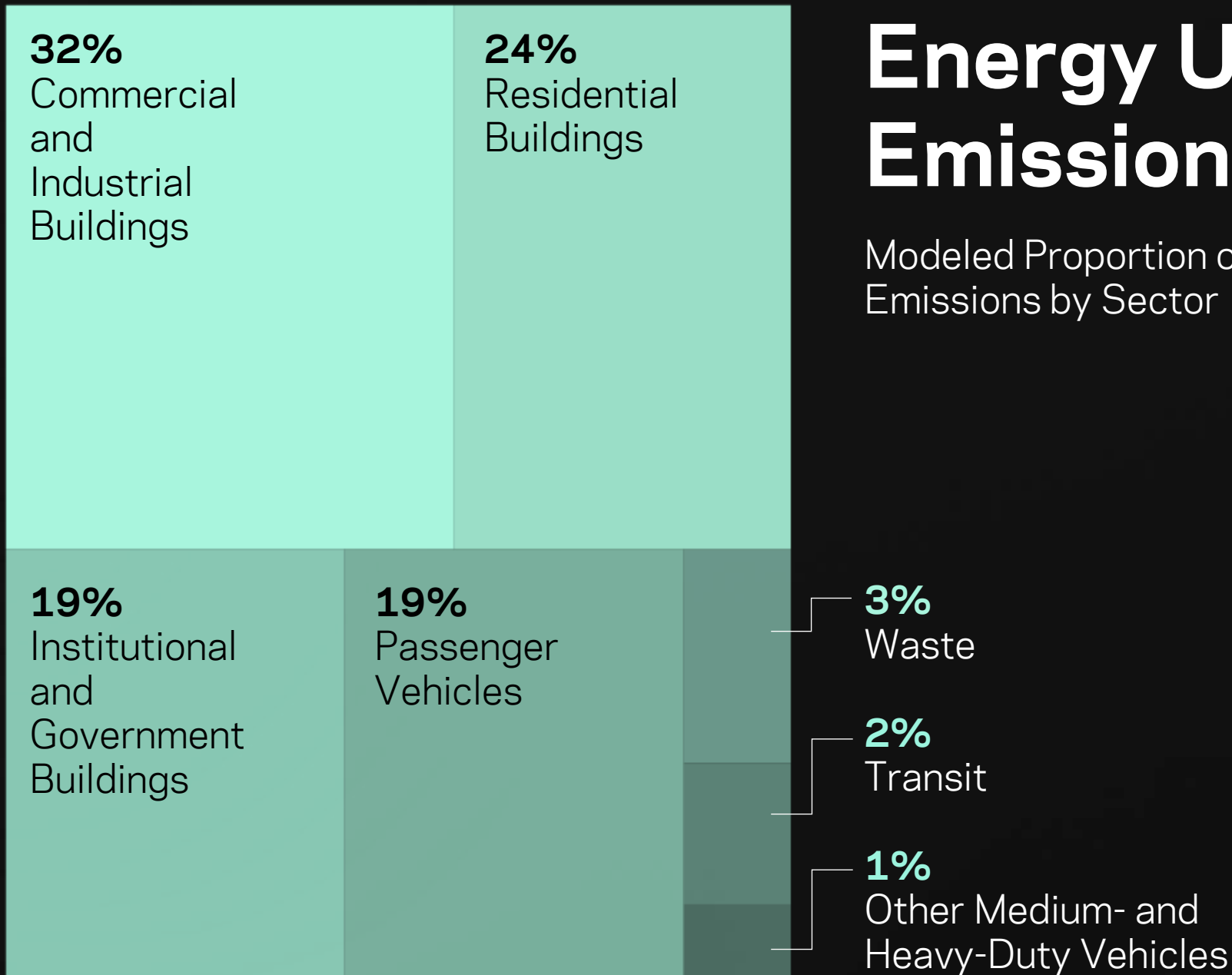
# Energy Use & Emissions in DC

Modeled Proportion of GHG  
Emissions by Sector

**3%**  
Waste

**2%**  
Transit

**1%**  
Other Medium- and  
Heavy-Duty Vehicles





# Percent of Emissions from Seattle's Largest Buildings

Nonresidential & Multifamily  
buildings > 20,000 SF  
(Excluding Parking)

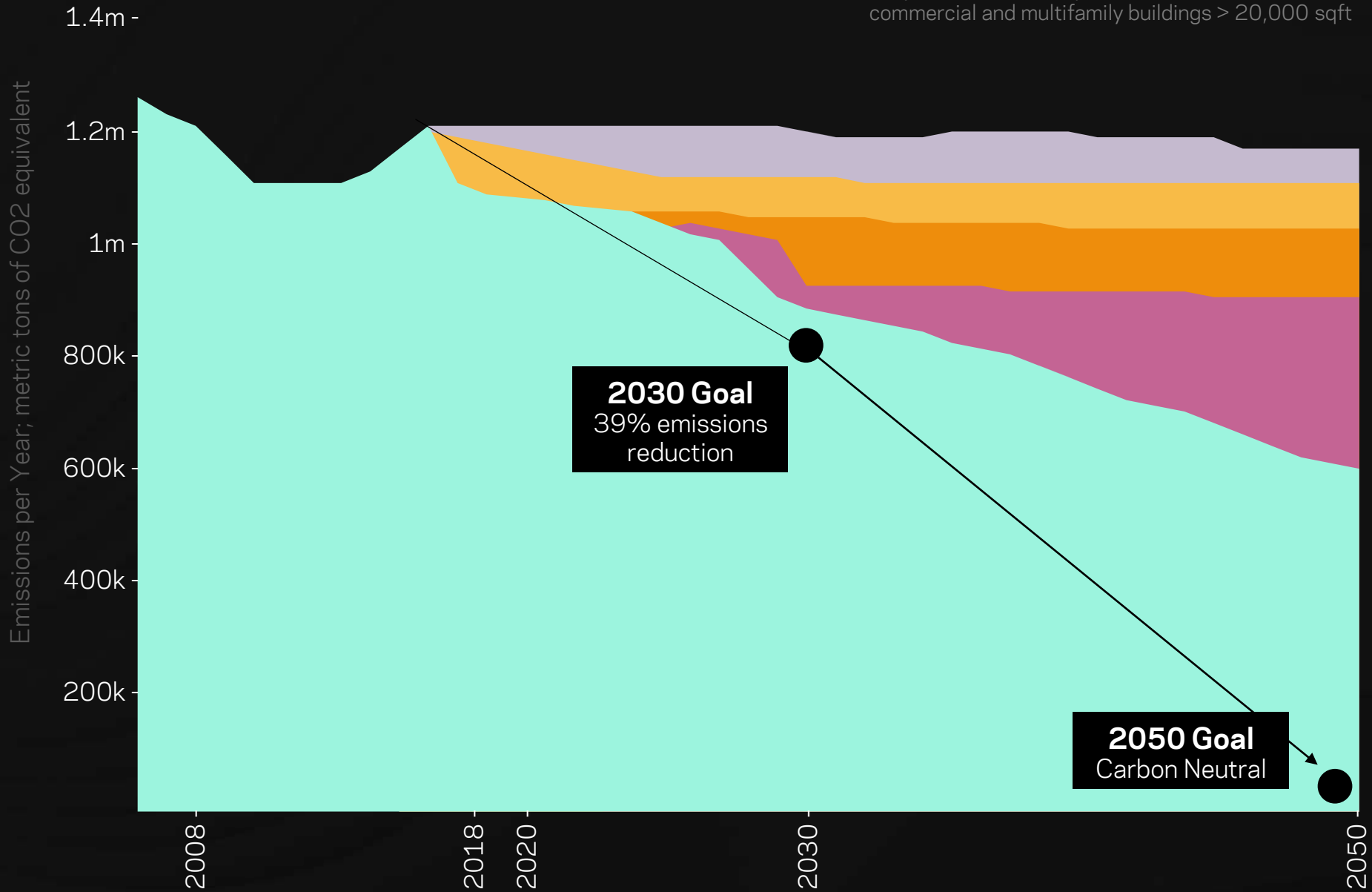
**65%** Nonresidential  
**50,000 ft<sup>2</sup>+**  
740 Properties

**17%** Multifamily  
**50,000 ft<sup>2</sup>+**  
605 Properties

**12%** Nonresidential  
**20,000- 50,000 ft<sup>2</sup>**  
709 Properties

**6%** Multifamily  
**20,000- 50,000 ft<sup>2</sup>**  
709 Properties

\*Policy still under development 27% assumes BPS for commercial and multifamily buildings > 20,000 sqft



Residential Heating Oil Conversations  
**8% Decrease**

Commercial Building Tune-Ups  
**2% Decrease**

State Energy Performance Standards  
**2% Decrease**

Seattle Building Performance Standards\*  
**27% Decrease**

Cumulative Emissions

# Timeline of Building Performance Regulations

## 1970s Codes & Standards

- Building energy codes
- Utility rebate programs
- National appliance standards



## 2000s Disclosure

- Benchmarking policies



## 2020s Performance

- Carbon centered regulations
- Equity and environmental justice
- Building performance standards



## 1990s Market Leadership

- ENERGY STAR released
- LEED Standards released



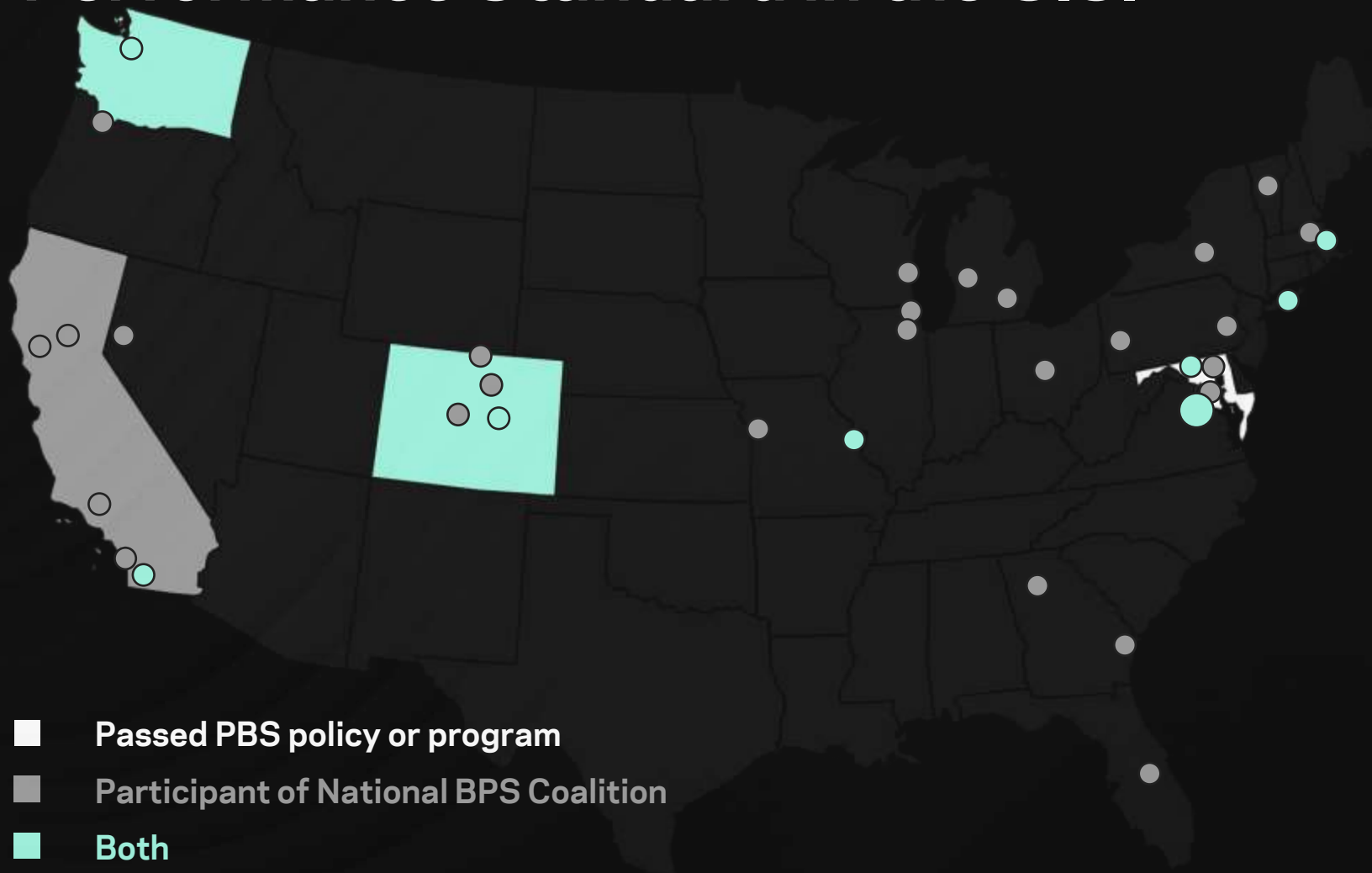
## 2010s Zero Energy

- NZE Certifications released
- GTZ Database created





# The State of Building Performance Standard in the U.S.



- Passed BPS policy or program
- Participant of National BPS Coalition
- Both

**Washington**

- Seattle

Portland, OR

**California**

- Sacramento
- San Francisco
- Los Angeles
- County of Los Angeles
- **Chula Vista**
- San Diego

Reno, NV

**Colorado**

- Boulder
- Fort Collins
- **Denver**
- Aspen

Milwaukee, WI

Evanston, IL

Chicago, IL

**St. Louis, MO**

Kansas City, MO

Grand Rapids, MI  
Ann Arbor, MI

Columbus, OH

Atlanta, GA  
Savannah, GA

Orlando, FL

Montpelier, VT

Ithaca, NY

**New York, NY**

Pittsburg, PA  
Philadelphia, PA

**Maryland**

- Annapolis
- **Montgomery County**
- Prince George's County

Cambridge, MA

**Boston, MA**

**Washington, DC**

# Energy vs Carbon-based Standards

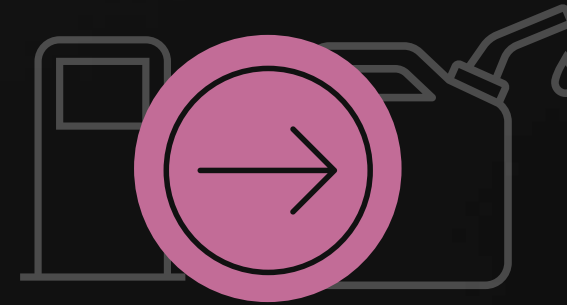


**Steam**  
**193**

Lbs CO<sup>2</sup>e/mmBTU

**Electricity**  
**185**

Lbs CO<sup>2</sup>e/mmBTU



**Natural Gas**  
**117**

Lbs CO<sup>2</sup>e/mmBTU

**Fuel Oil**  
**163**

Lbs CO<sup>2</sup>e/mmBTU

# Greenhouse Gas Intensity **GHGI** Metric



**Total Annual  
Emissions**

Emissions factors by fuel  
type to be specified in rule



**Total Square  
Feet**

ft<sup>2</sup>

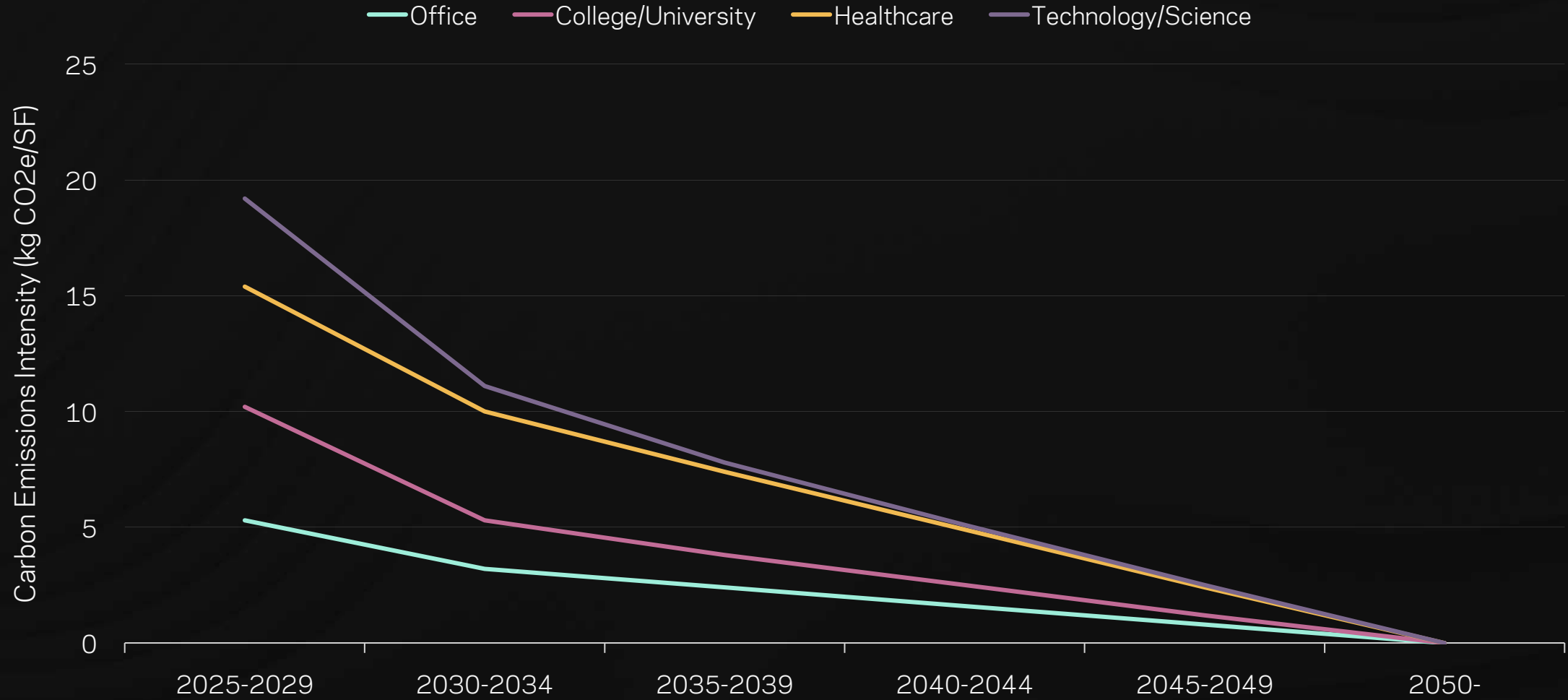
**Greenhouse Gas  
Intensity**

**GHGI  
kgCO<sub>2</sub>e/ft<sup>2</sup>/yr**

CO<sub>2</sub>e is a carbon dioxide  
equivalent



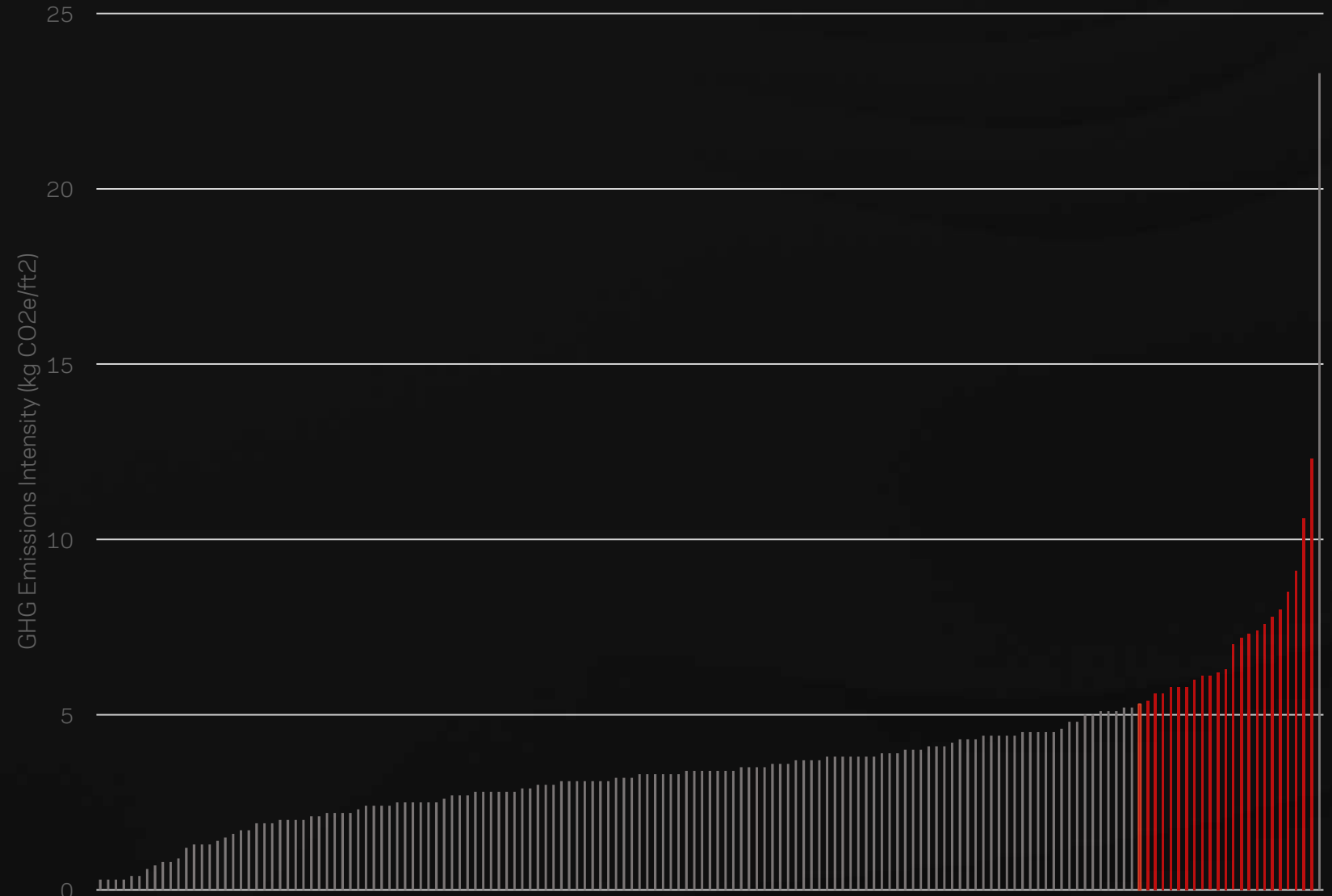
# Boston's BERDO 2.0



# Boston's BERDO 2.0

24/157 office  
buildings non-  
compliant with 2025  
emissions standard

Boston Office Buildings, 2020 Data



# Penalties

## A variety of approaches



**\$234**

MT CO<sub>2</sub>e ACP

**Boston**



**\$10**

GSF (max)

**Washington, DC**



**\$1**

GSF (18 months max)

**Washington State**



# Impact on design decision making

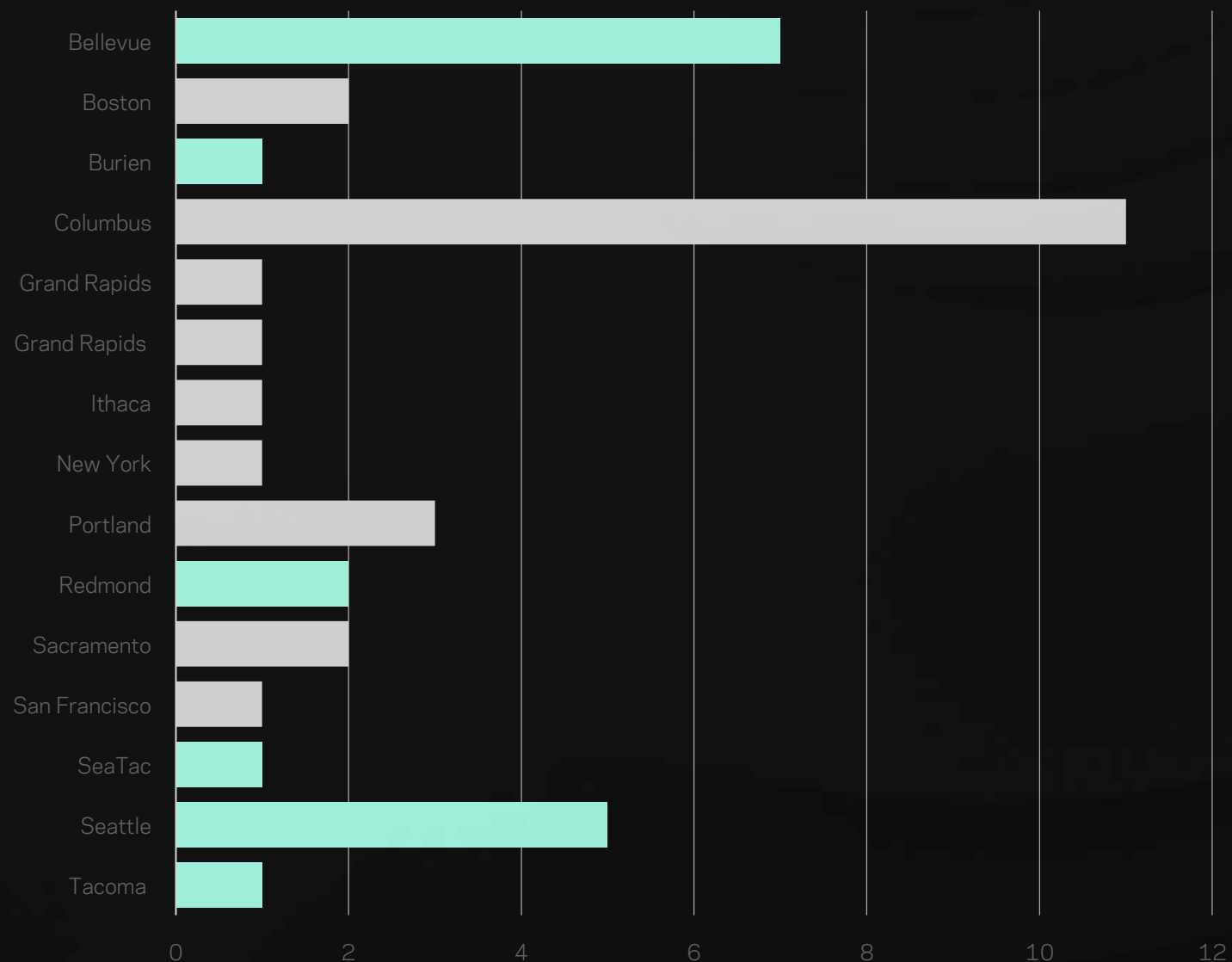
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40 Projects >  
50,000 sq.ft.  
in regions  
adopting BPS

Significant impact to  
NBBJ



## Opportunity

### Repositioning in conjunction with deep energy retrofits

140 Broadway | Office

**9.95**

GHG Intensity  
kgCO<sub>2</sub>/ft<sup>2</sup>

#### GHG Intensity Target\*

2024 Target **8.46** kgCO<sub>2</sub>/ft<sup>2</sup>

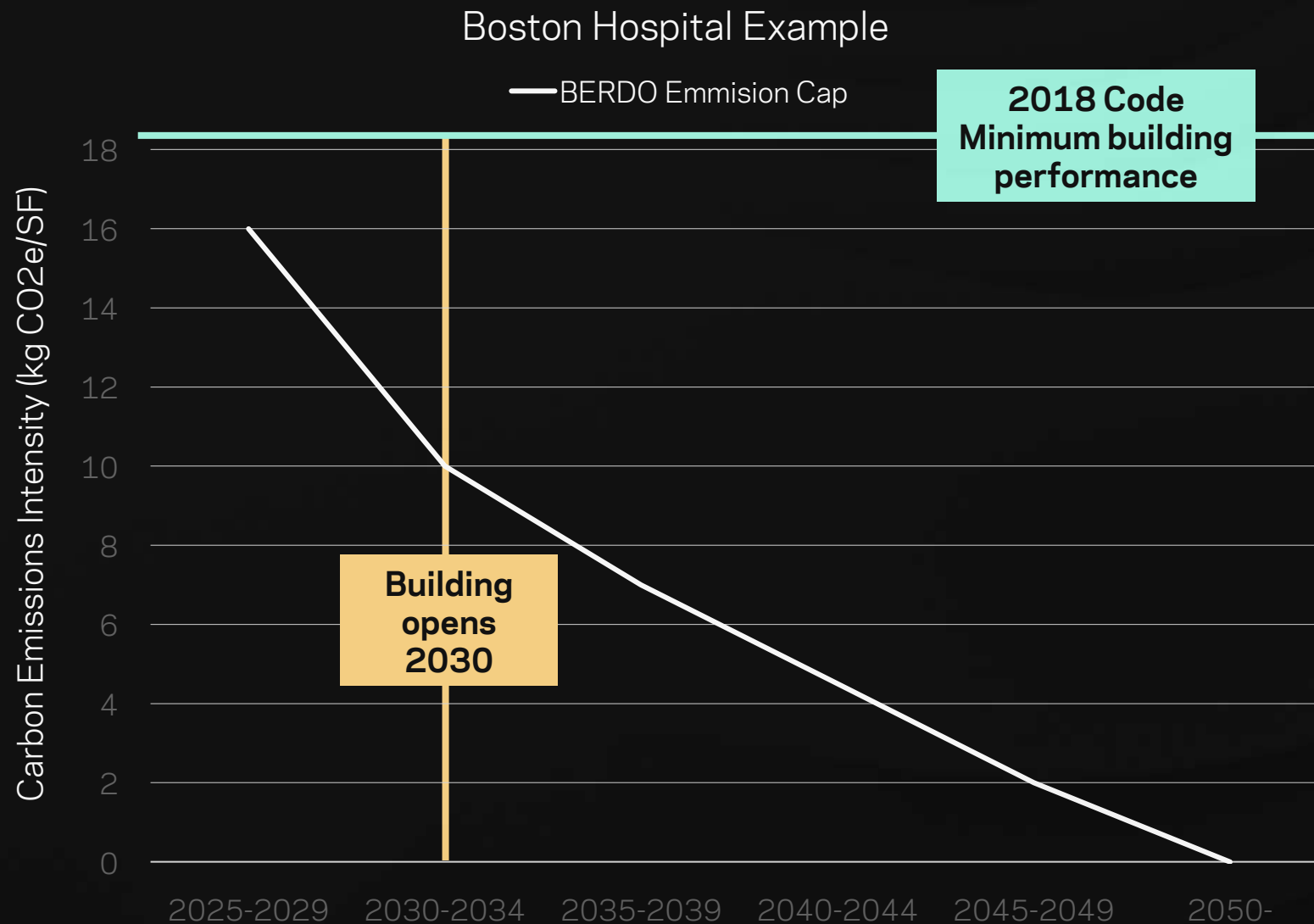
2030 Target **4.53** kgCO<sub>2</sub>/ft<sup>2</sup>



# Impact to new building design

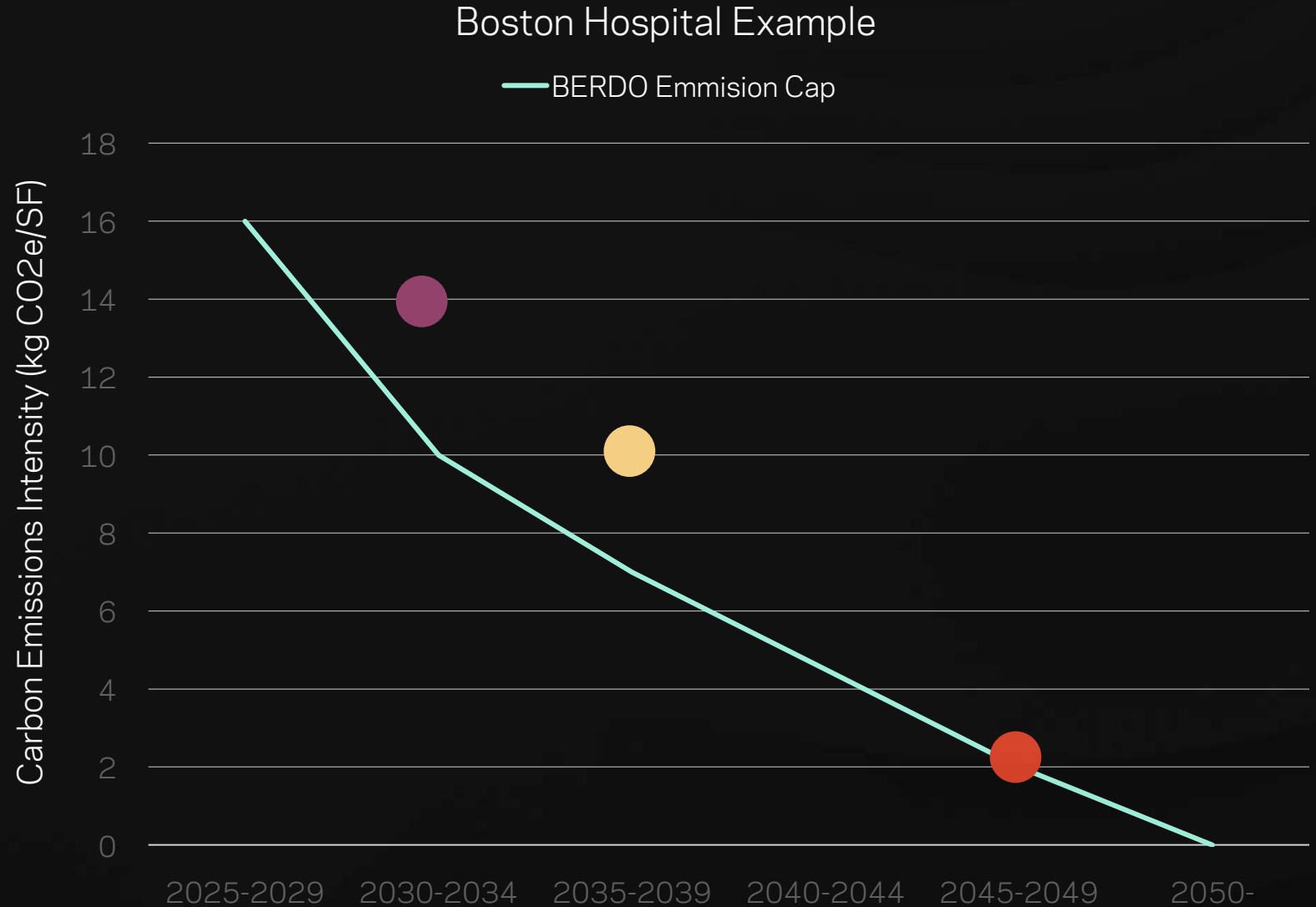
## A driver for change

- Code minimum design in 2030
- \$5m+ fine on Day 1

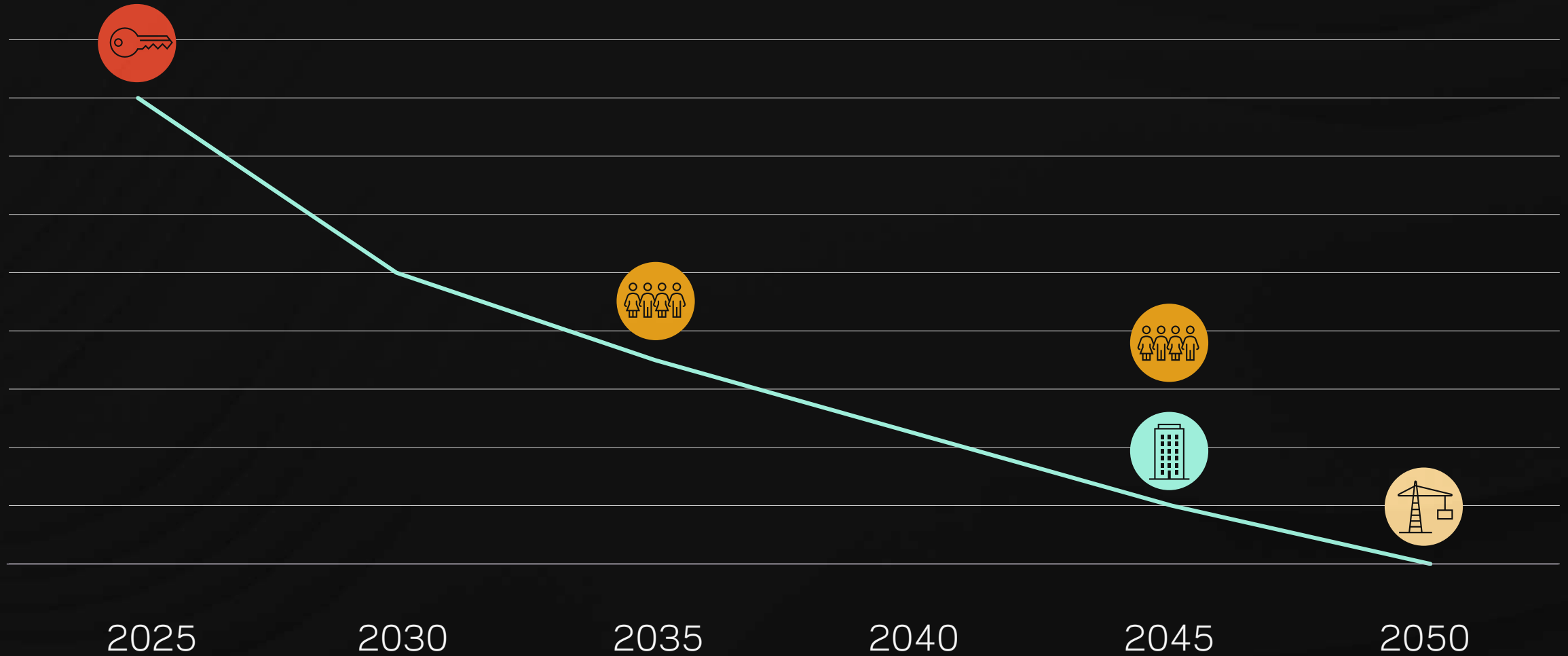


# Impact to new building design

- Current grid
- Projected 2035 grid
- with RECs



# Linkage to RMI's Zero over Time Approach



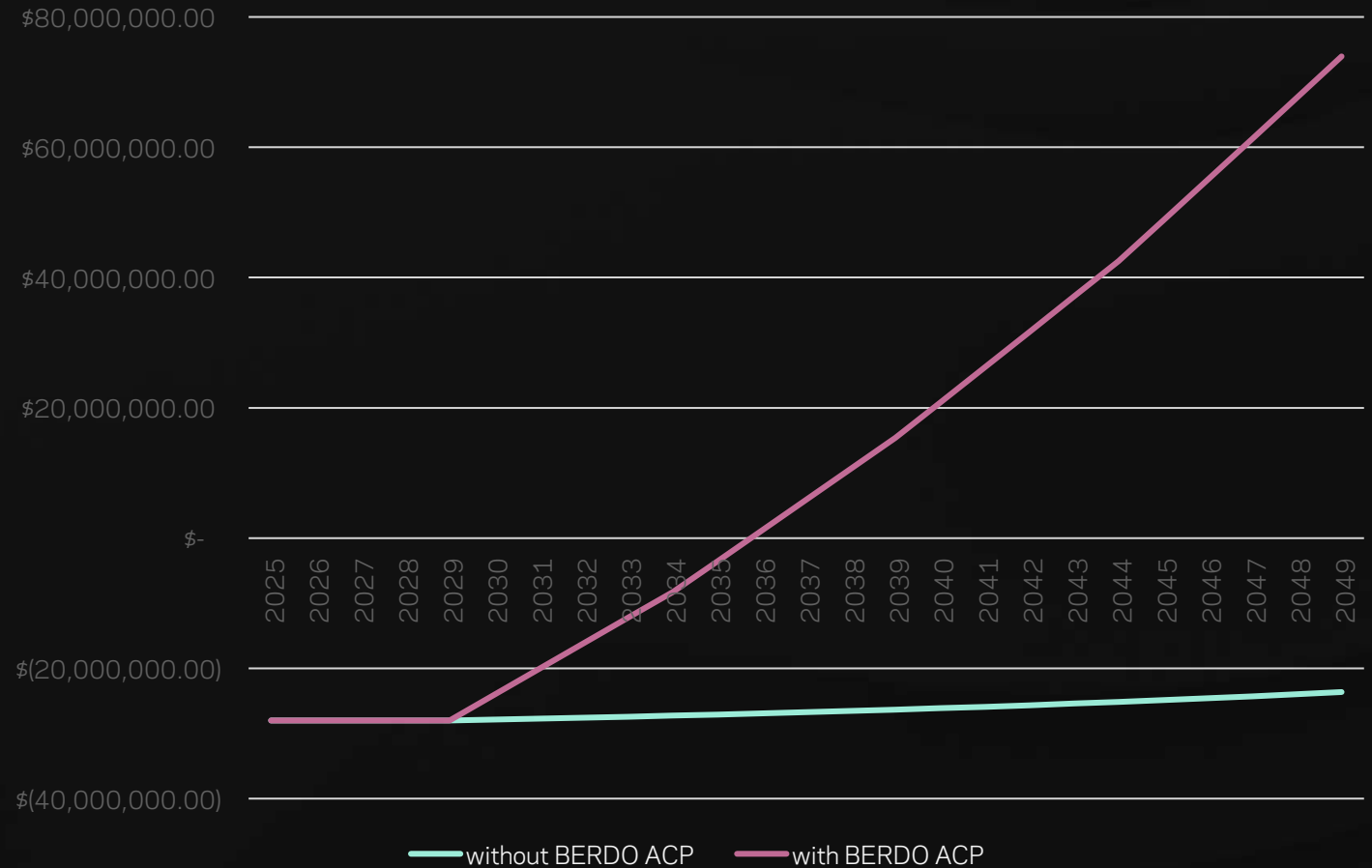


# Impact of the cost of carbon BERDO 2.0

\$28m investment yields

10% IRR with BERDO ACP

Cumulative Cashflow: Boston Hospital Example  
(2018 Code Minimum vs 85% Electrified Option)



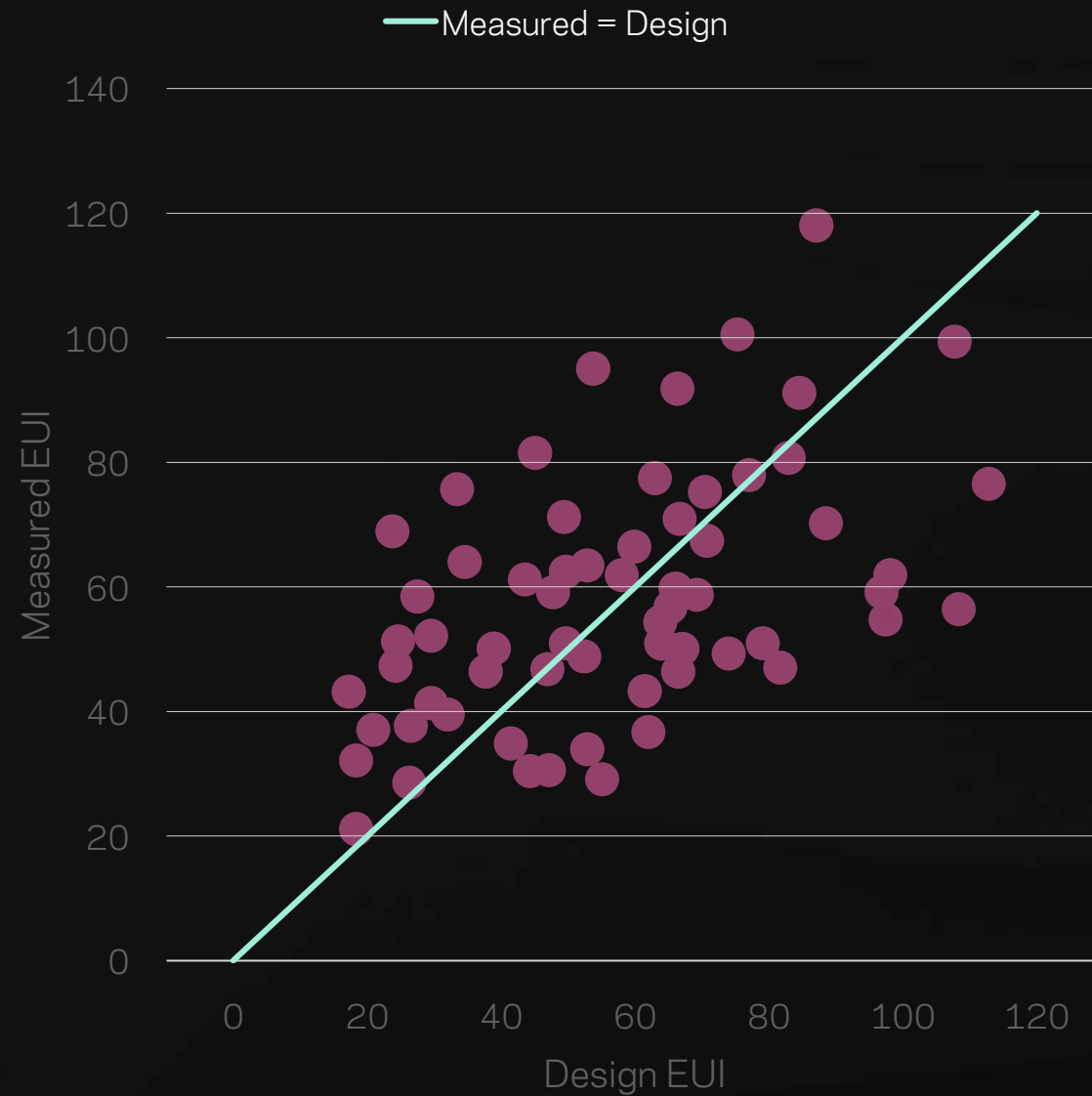
# Impact on energy design process

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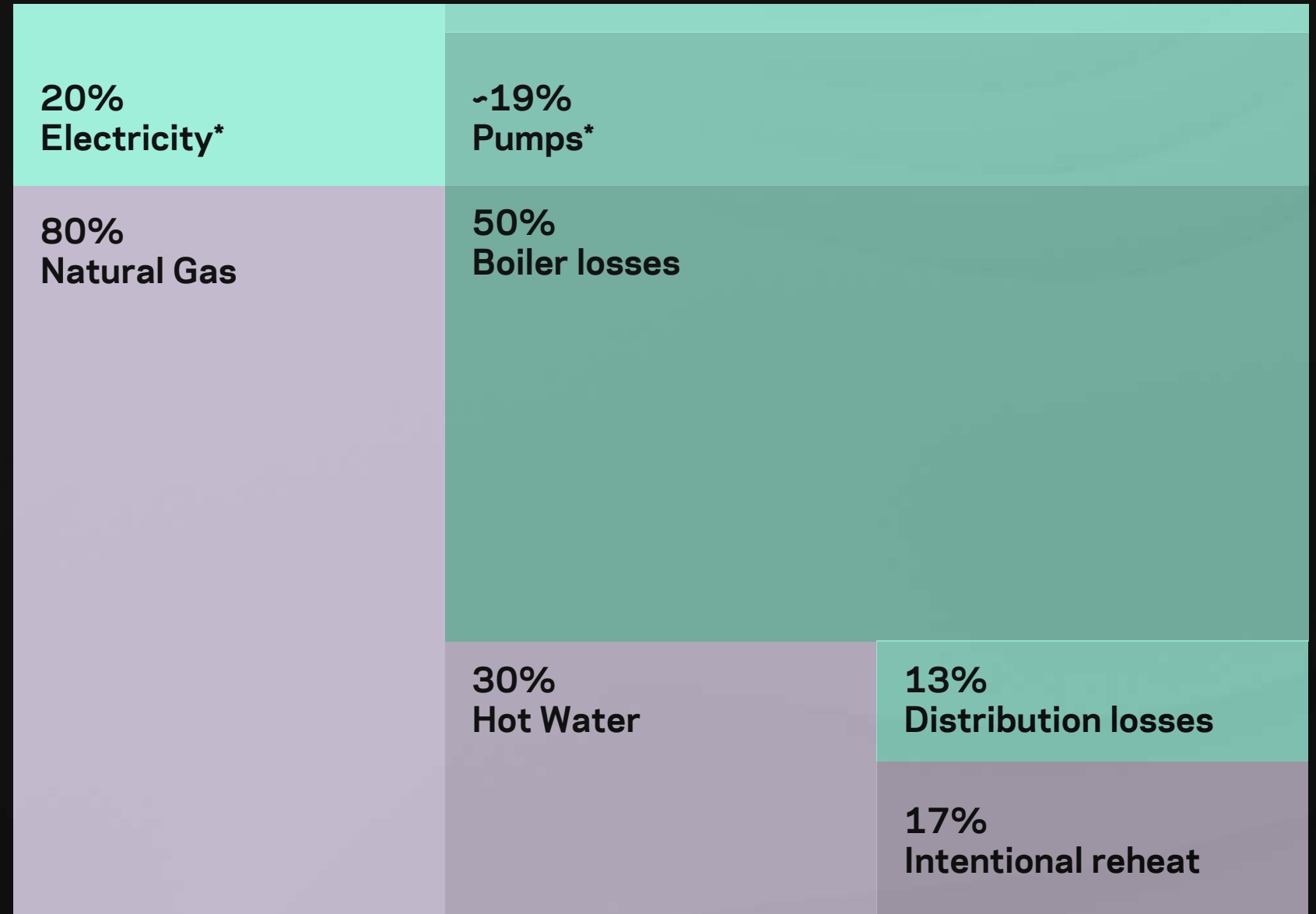
# Real vs Modeled Performance



<1% Boiler auxiliary\*

# Real vs Modeled Performance

Total reheat energy cost

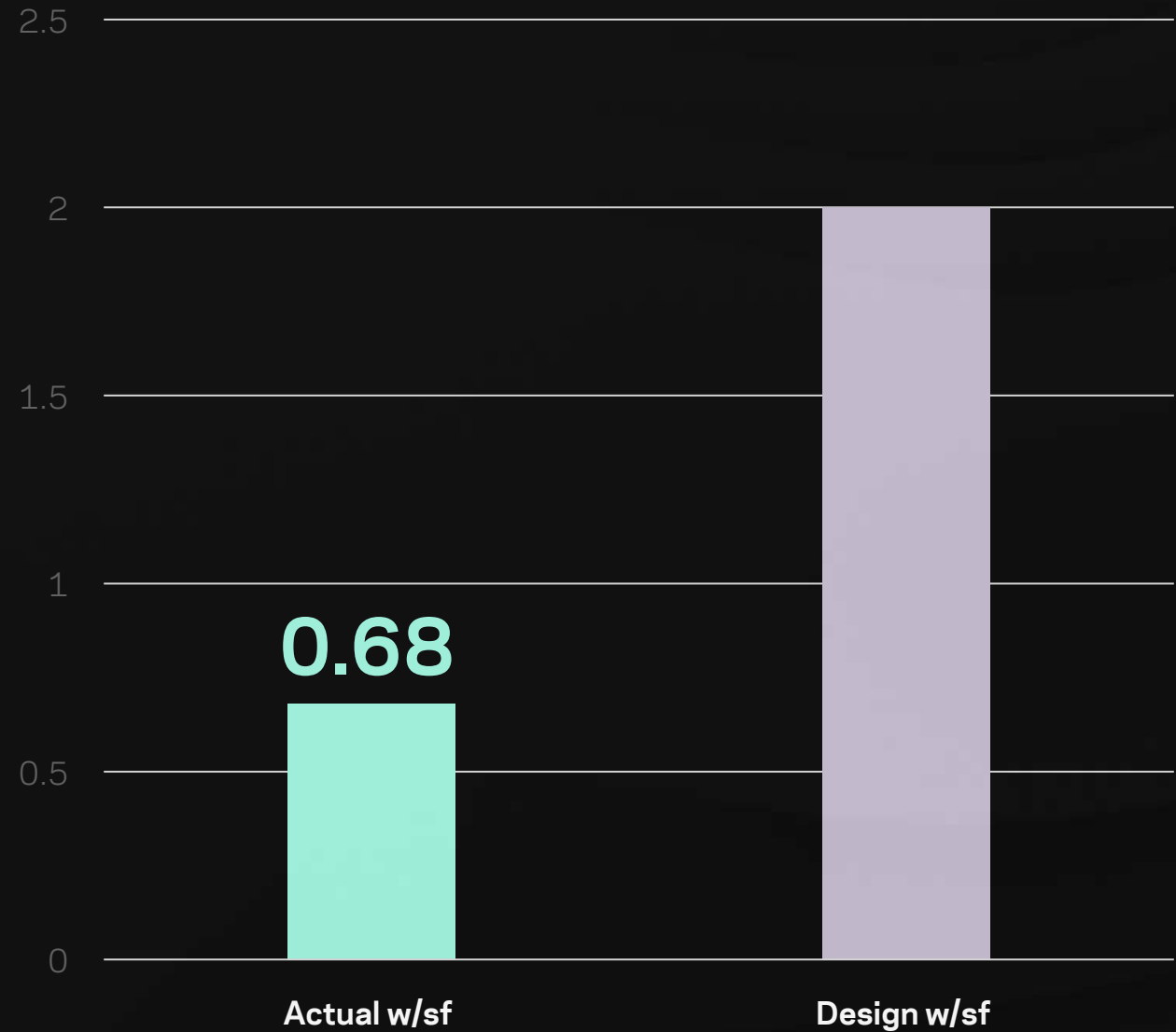


\*estimated

Raftery, P., A. Geronazzo, H. Cheng, and G. Paliaga. 2018. Quantifying energy losses in hot water reheat systems. *Energy and Buildings*, 179: 183-199. November

# Real vs Modeled Performance

Plug loads



Source: McKinstry study of downtown Seattle tech office building

# Beyond ASHRAE 90.1

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## Informative Note

Neither the proposed building performance nor the baseline building performance are predictions of actual energy consumption or costs for the proposed design after construction. Actual experience will differ from these calculations due to variations such as occupancy, building operation and maintenance, weather, energy use not covered by this procedure, changes in energy rates between design of the building and occupancy, and the precision of the calculation tool.

- “all conditioned spaces shall be simulated as being both heated and cooled, even if no heating or cooling system is to be installed”
- Fixed, default air leakage for infiltration
- Unrealistic usage schedules
- “Piping losses shall not be modeled”
- Generally, no modeling of transformer losses
- ...



# Beyond Regulated Loads

Plug load management



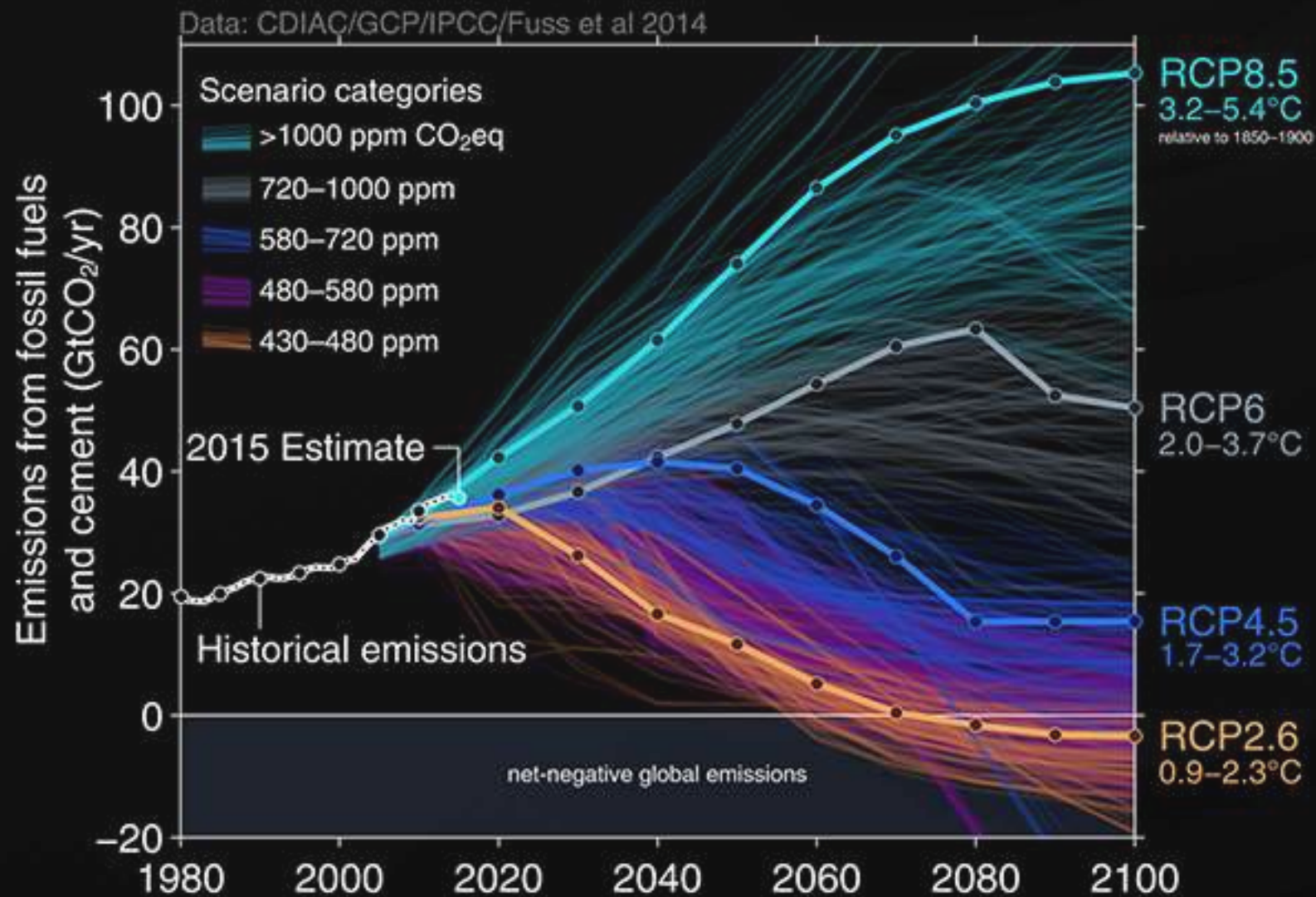
# Uncertainty

Weather variations



# Uncertainty

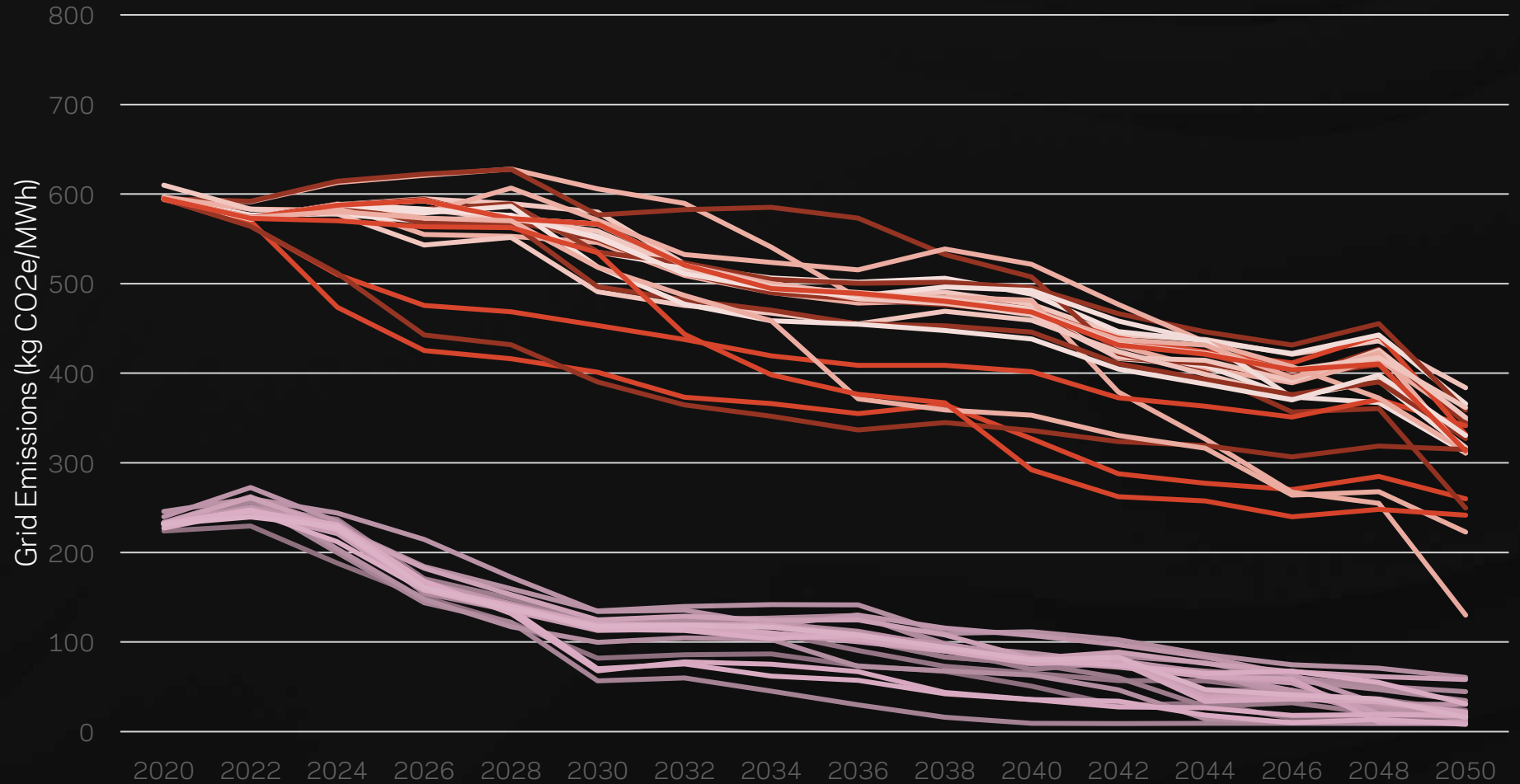
Climate change



# Uncertainty

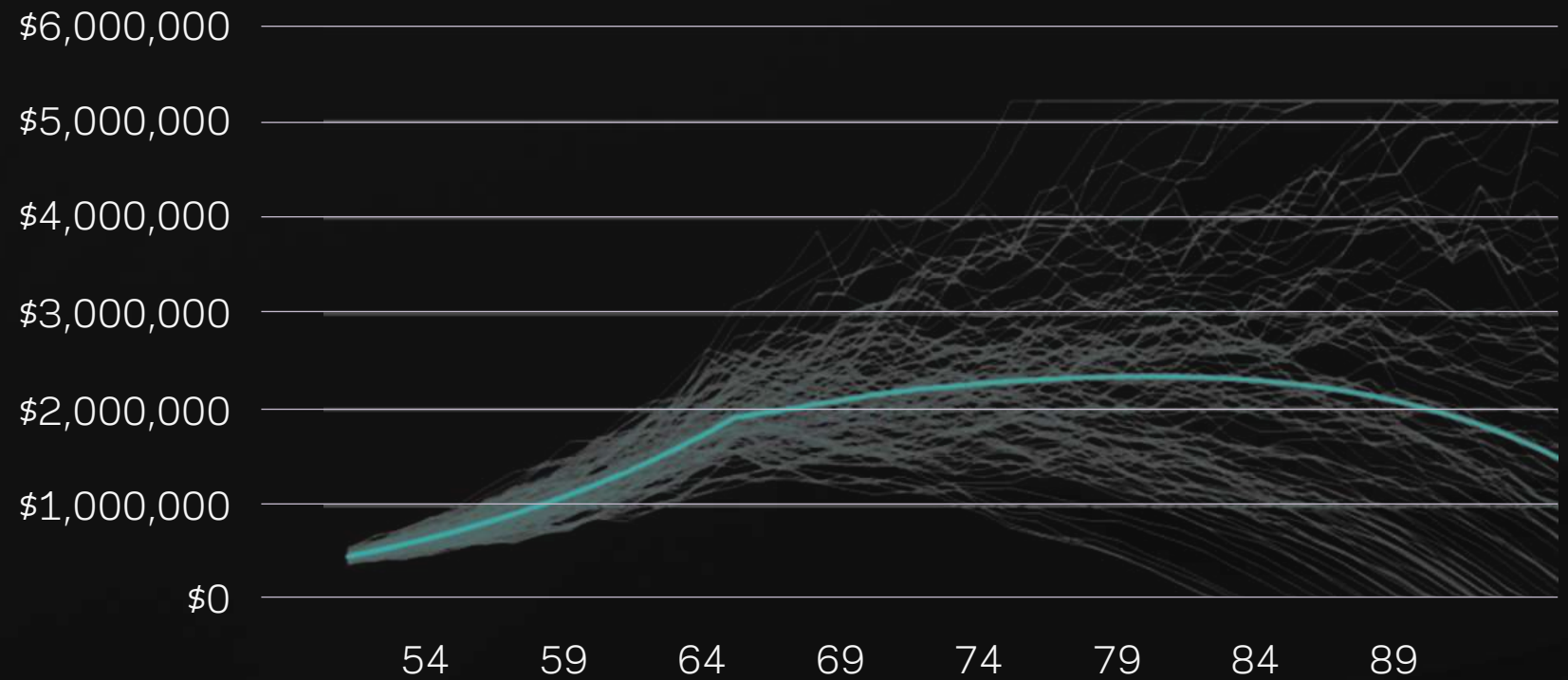
Future grid

Predicted Electric Grid: Massachusetts vs Ohio  
NREL Cambium, multiple scenarios



# Uncertainty

What do we tell our  
clients?



# Probabilistic Modeling

## What do we tell our clients?



*or*



**37.4 EUI**

**35 - 42 EUI**

(75% confidence)



# Conclusions

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- **Building performance standards can:**
  - Regulate carbon emissions explicitly
  - Give owners a long-term horizon for planning
  - Incorporate social cost of carbon into decision-making
- **Impact on new construction & design process:**
  - Beyond code thinking – extended life span
  - Penalties bring reputational impacts
  - Focus on real performance outcomes & real usage
  - Change life cycle cost analyses
  - Probabilistic, multivariable modeling with uncertainty

# Q&A

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