CALCULATING **THE CARBON FOOTPRINT** OF WORK

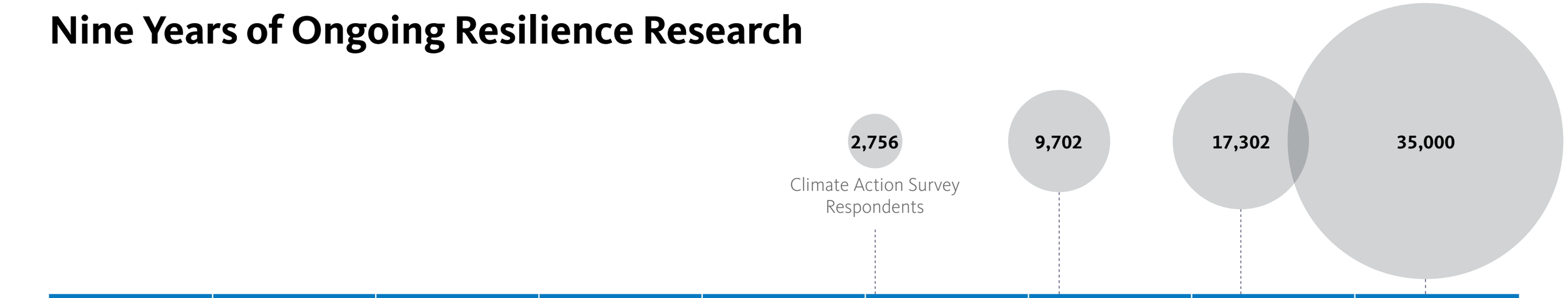
A Collaboration between
the Gensler Research Institute &
the MIT Mobility Initiative

Gensler **RESEARCH** INSTITUTE

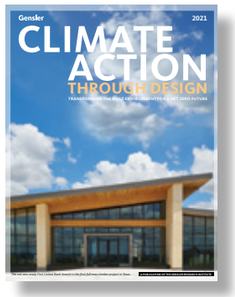
MIT Mobility Initiative

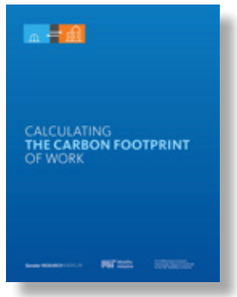
Gensler is a research-based design firm.

Nine Years of Ongoing Resilience Research



2016	2017	2018	2020	2021	2022	2023	2024	2025
Climate Change: Impact Through Design	Impact by Design	Impact by Design	Impact by Design	Climate Action Through Design	U.S. Climate Action Survey	Global Climate Action Survey	Global Climate Action Survey	Climate Action Through Design
					Climate Action Through Design	The Carbon Footprint of Work	Climate Action Through Design	The Mixed-Use Tower of the Future
						Designing for Lower Carbon Concrete		The Carbon Footprint of Work



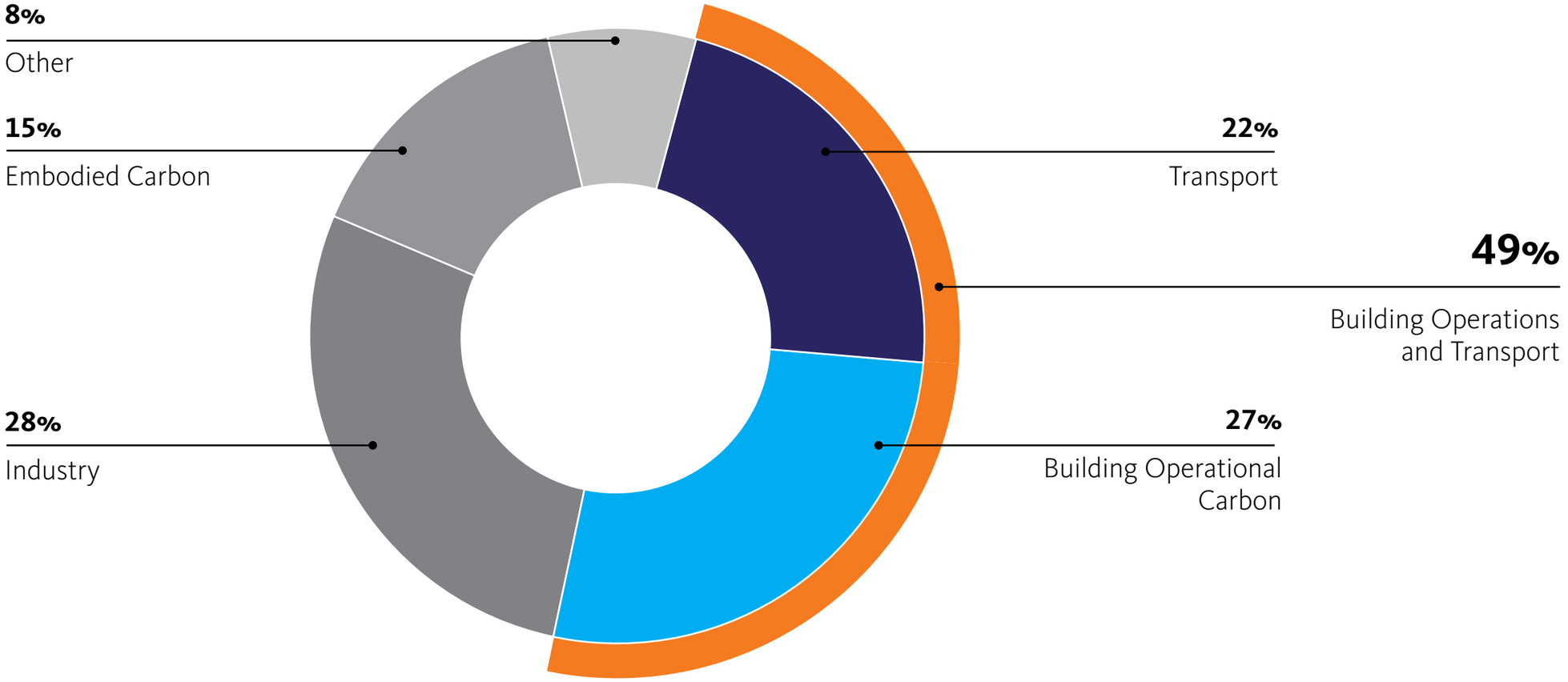


In the U.S., roughly a third of the working population has jobs that can take place in an office environment.

Choices of where to work and how to commute can have significant impacts on carbon emissions.

Building operations and transportation represent half of all global carbon emissions.

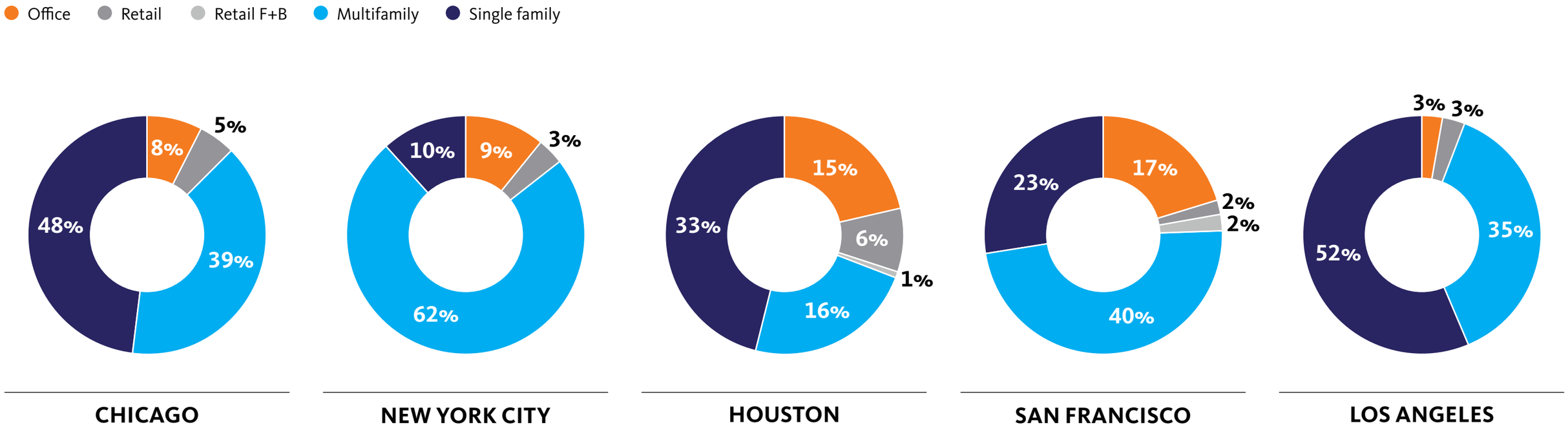
Annual Global Carbon Emissions by source.



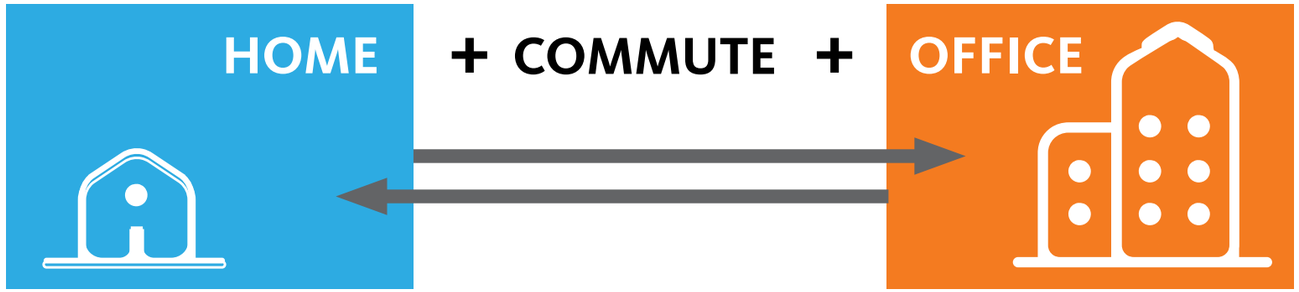
Source: Architecture 2030

Residential space represents the majority of the built environment in our cities.

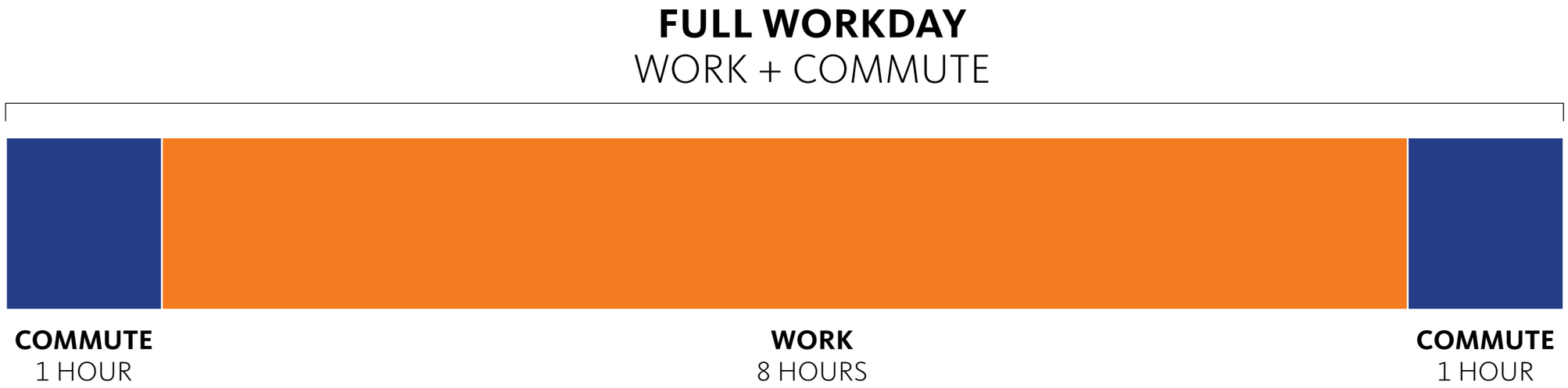
Approximate square footage of each building type in each city.

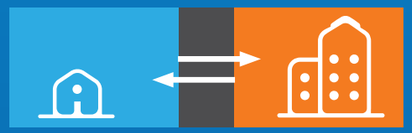


Our Approach to Calculating the Carbon Impact of Work



Our Definition of a Workday

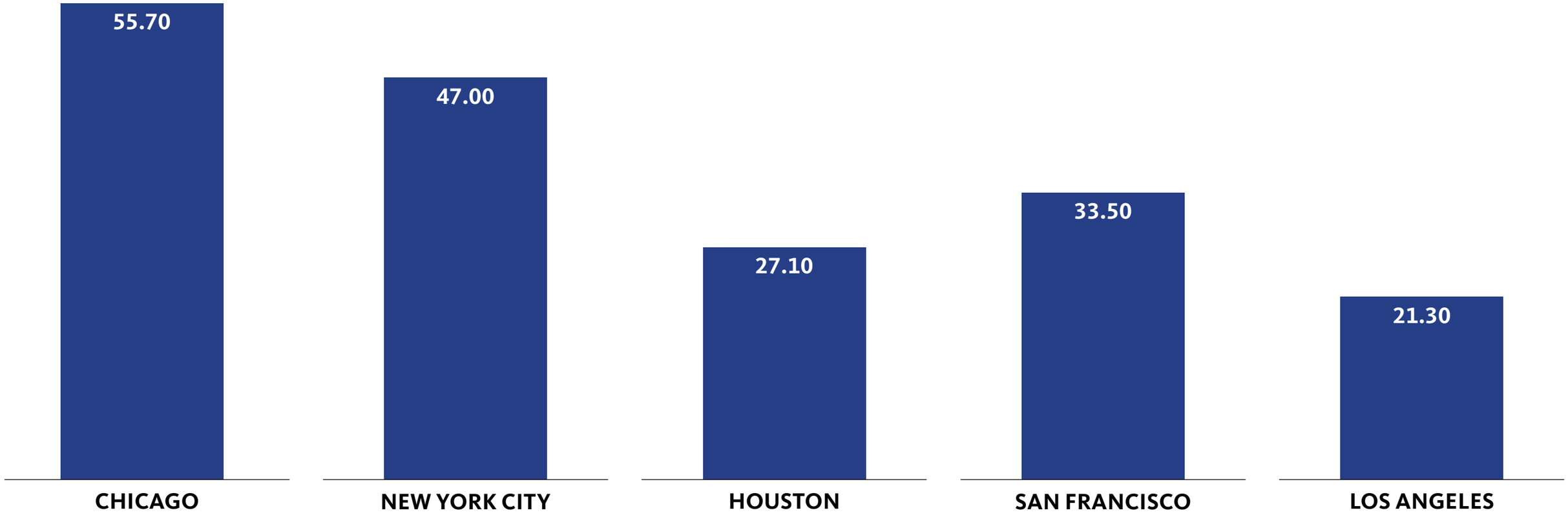




THE CARBON FOOTPRINT OF HOMES AND OFFICES

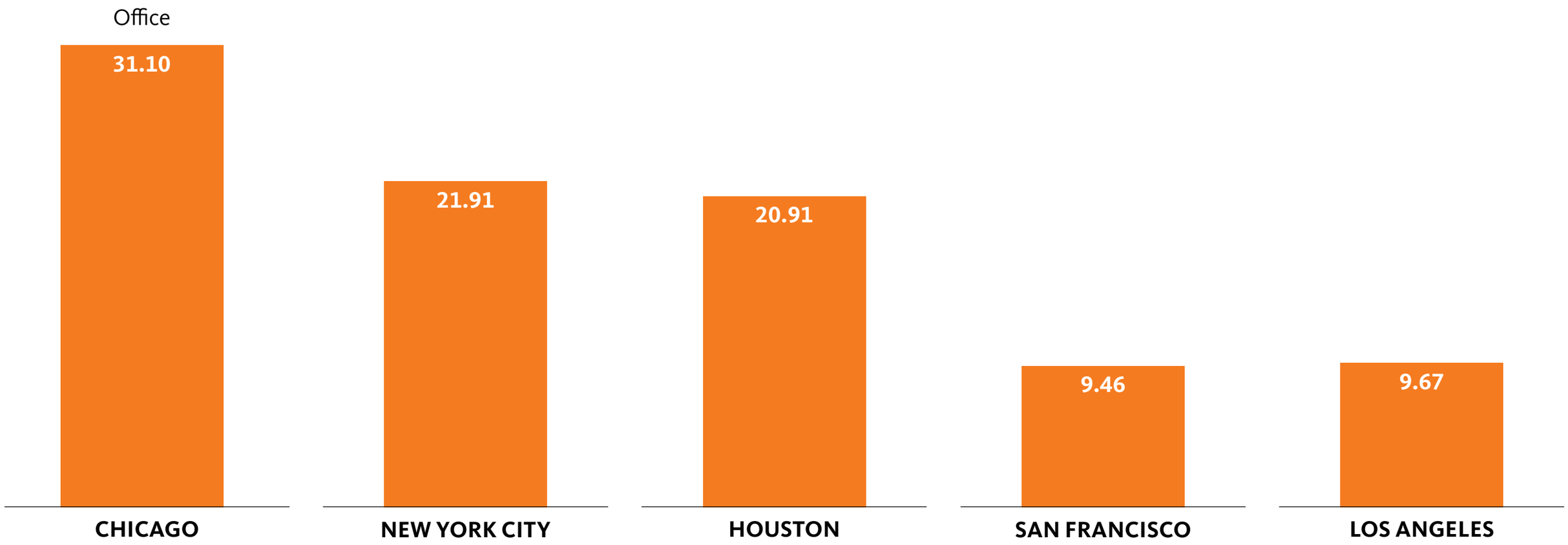
Energy use is higher in colder climates.

Energy Use Intensity (EUI) in kbtu/sf/year in the average single-family home in each city.



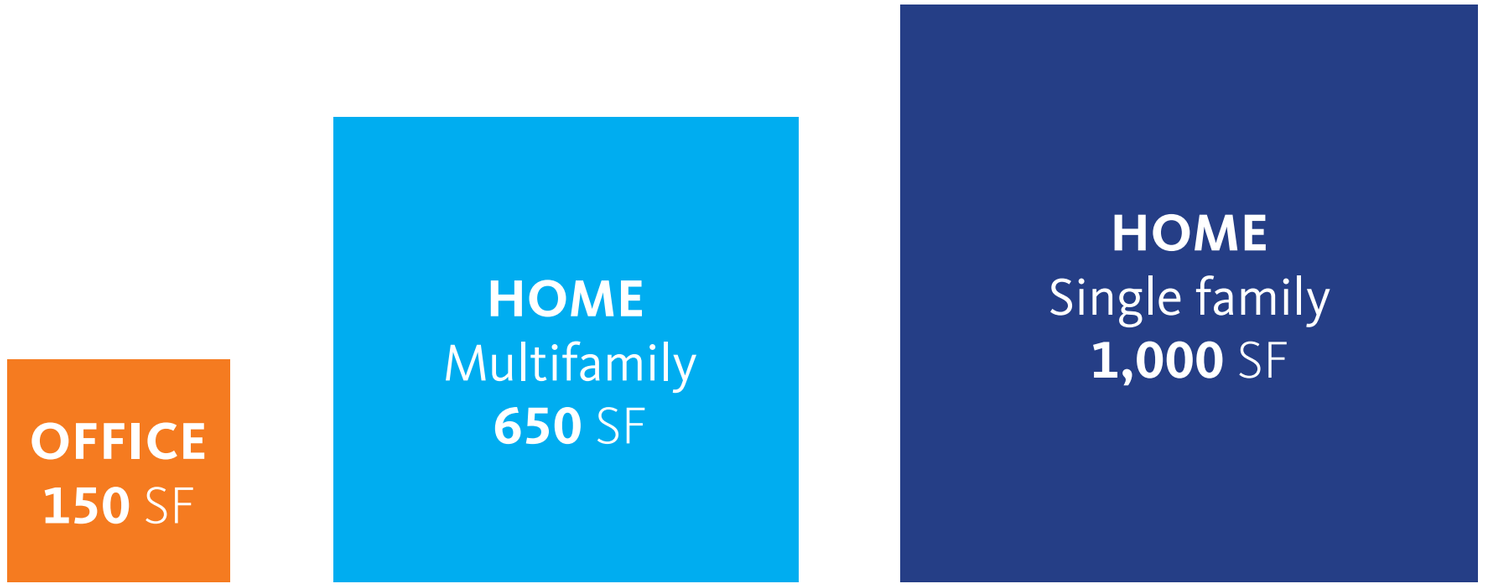
Carbon intensity varies depending on local grid composition.

Pounds of CO_2e emitted per square foot per year in the average office in each city.



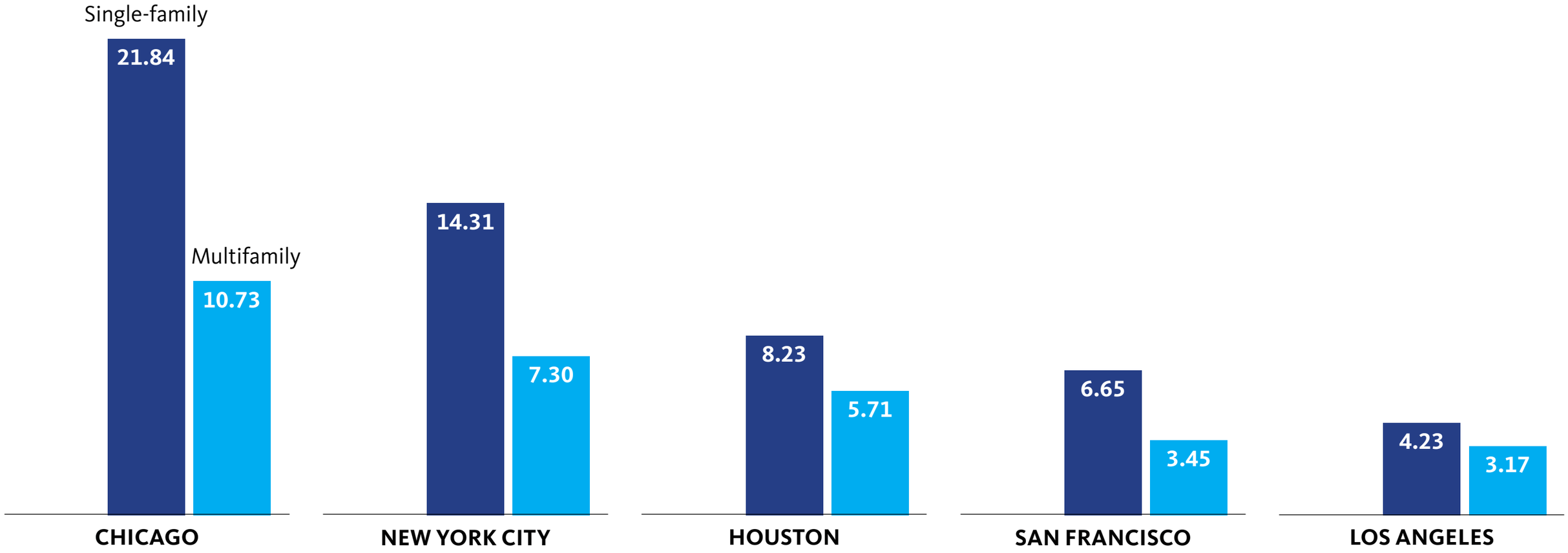
As workspaces, offices are more space efficient than homes.

Square footage occupied per person in each space type



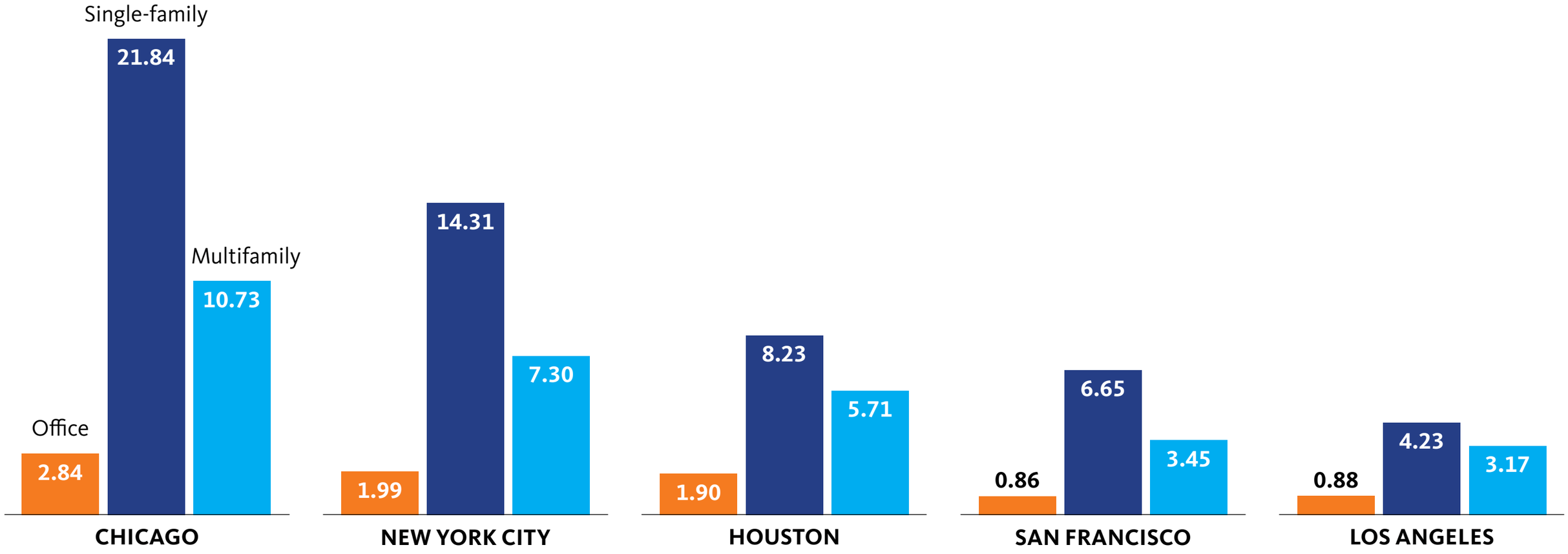
Single-family homes are more carbon-intensive per person than multifamily homes.

Metric tonnes of CO_2e per person per year in each housing type for five U.S. cities. Assumes industry average of 1,000 SF per person in single-family homes and 650 SF per person in multifamily homes.



Offices are more carbon-efficient per person than homes.

Metric tonnes of CO_2e/person/year emitted by each space type.



Our homes don’t disappear when we go to the office.

We can reduce energy use at our homes during the workday to better leverage the efficiency of offices.

Setbacks reduce the carbon impact of residences during the workday.

MILD SET BACK ↓ **−30%**

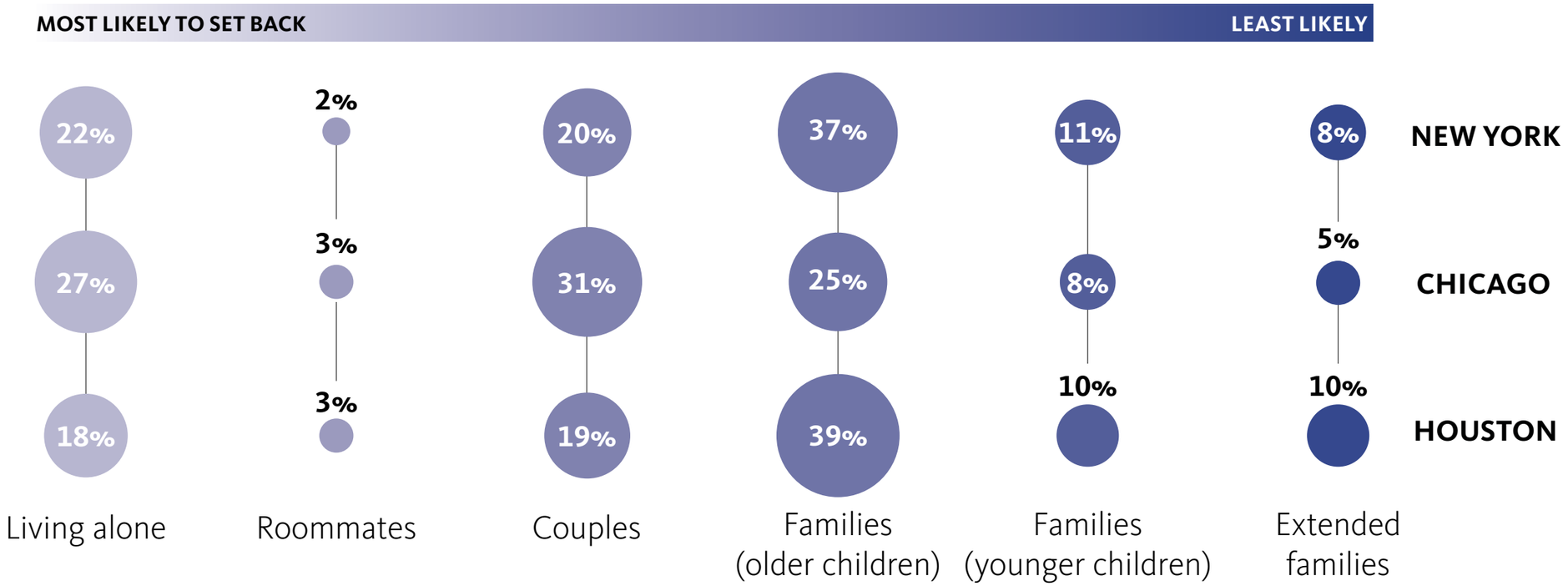
- Ten Hour HVAC Set Back
  - 80°F Cooling
  - 67°F Heating

AGGRESSIVE SET BACK ↓ **−60%**

- HVAC Off
- Lighting Off
- Reduce Plugloads
- Appliances on Standby

Close to half of people can comfortably set back their homes during the workday.

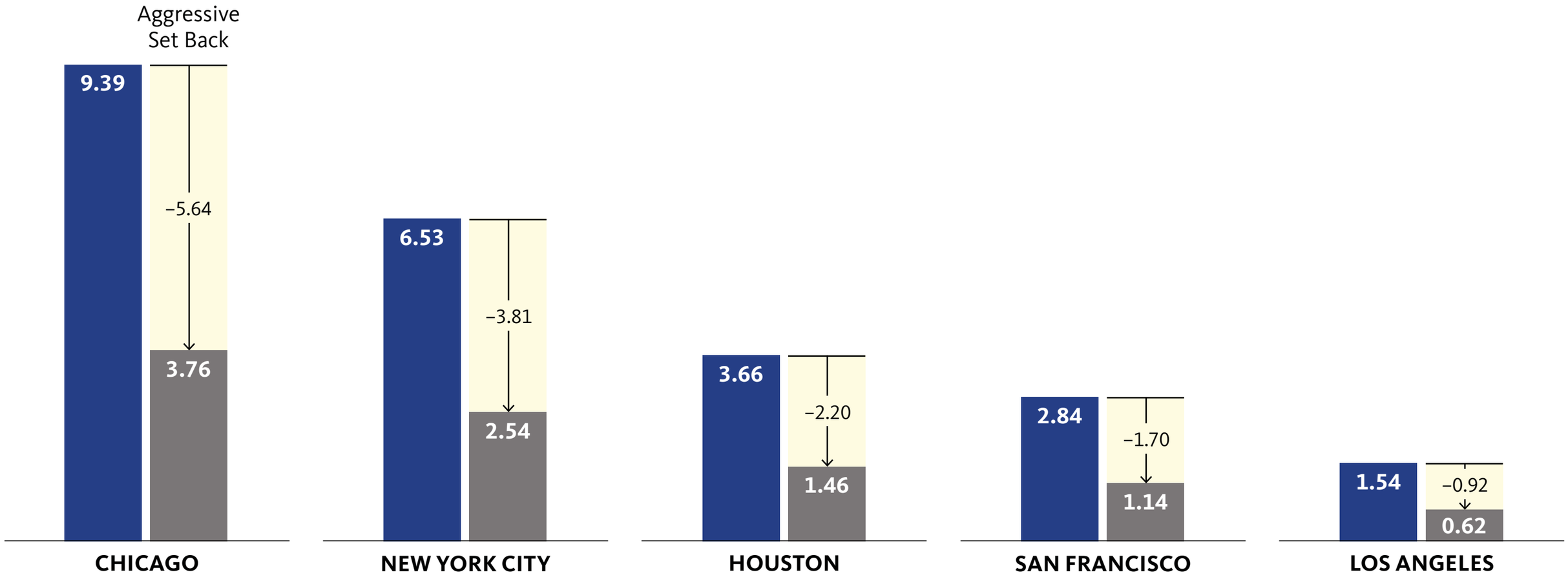
Percentage of individuals in each living situation, and relative likelihood of the home being left unoccupied for the full workday.



Source: City Pulse 2022 Urban Mobility Report data

Home emissions can be reduced by up to 60% through setbacks.

Baseline carbon emissions of single-family homes in each city compared to 60% setbacks.
All data expressed in metric tonnes/CO_2e/person/year.



Setbacks reduce the carbon impact of offices when all employees work from home.

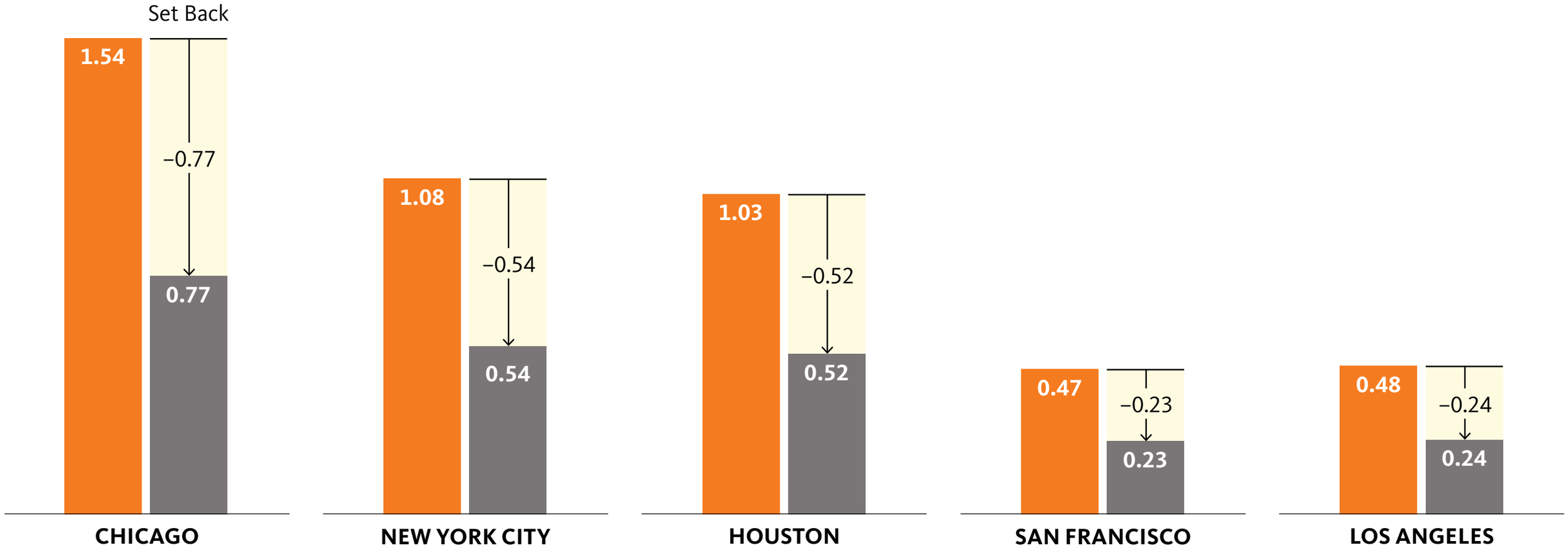
SET BACK **–50% energy use**

Typical weekend emissions of office not in use.
Maintains minimum operations at 50%.

Offices can be set back when they are entirely unoccupied — this is an organizational, not individual, decision.

Office emissions can be reduced up to 50% through setbacks.

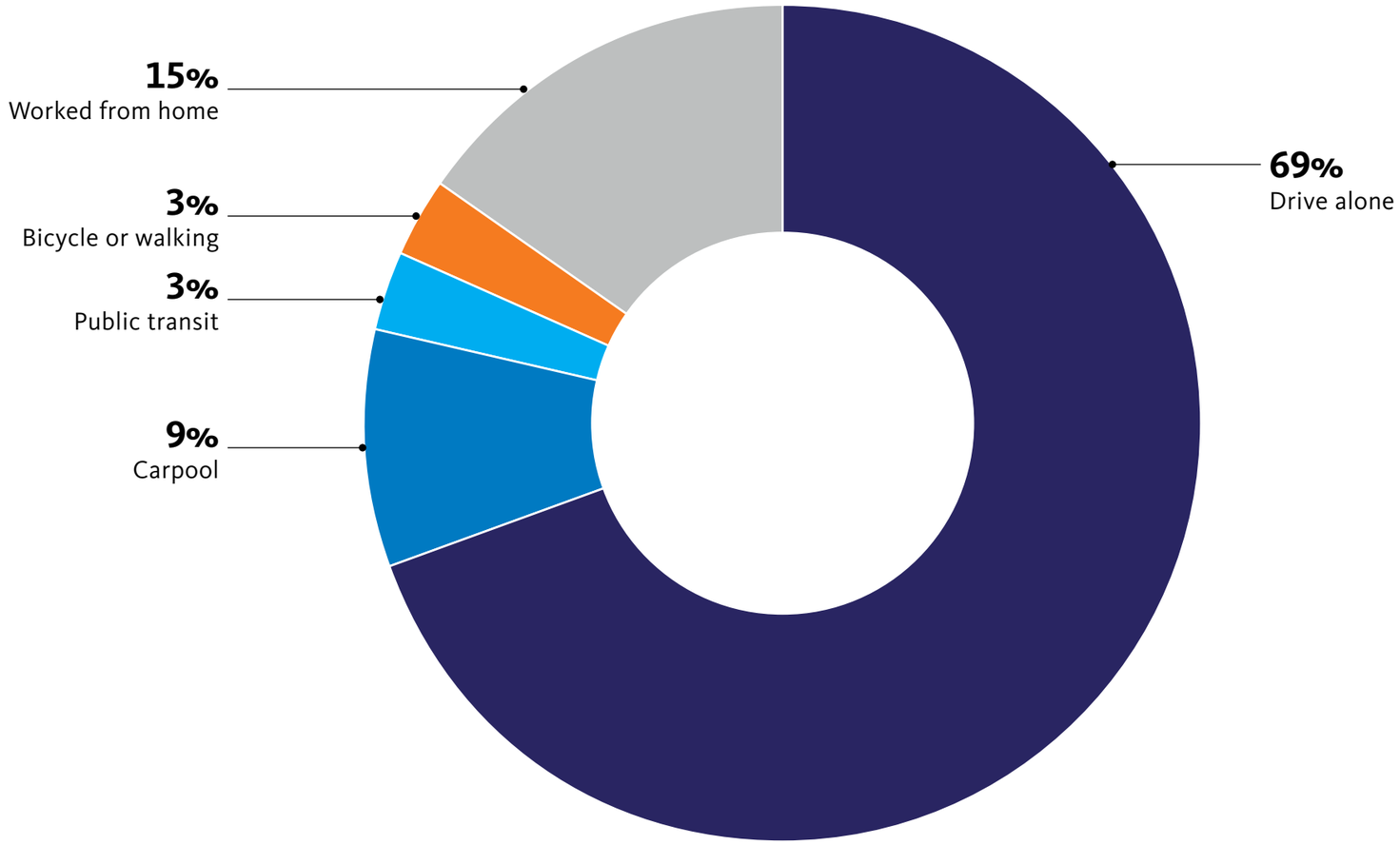
Baseline carbon emissions of offices in each city compared to 50% setbacks. All data expressed in lbs/CO_2e/person/year.



THE CARBON IMPACT OF THE COMMUTE

Most workers in the U.S. commute, and most commute by car.

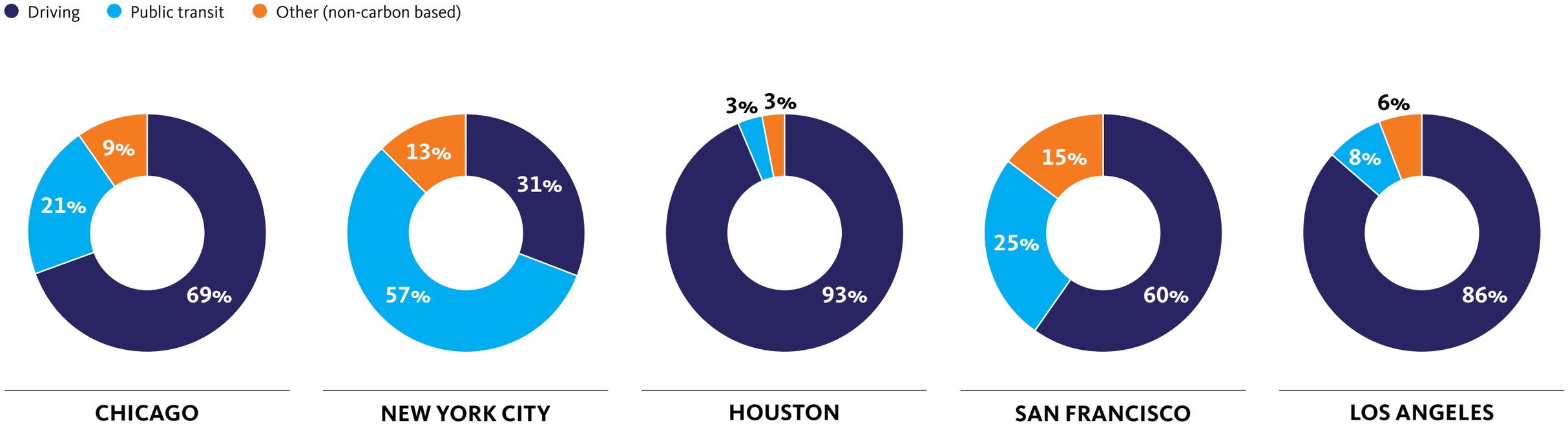
Reported commute mode for workers aged 16 or older living in the U.S.



Source: U.S. Census Bureau 2022

Cars are nationally dominant, but we see variation between cities.

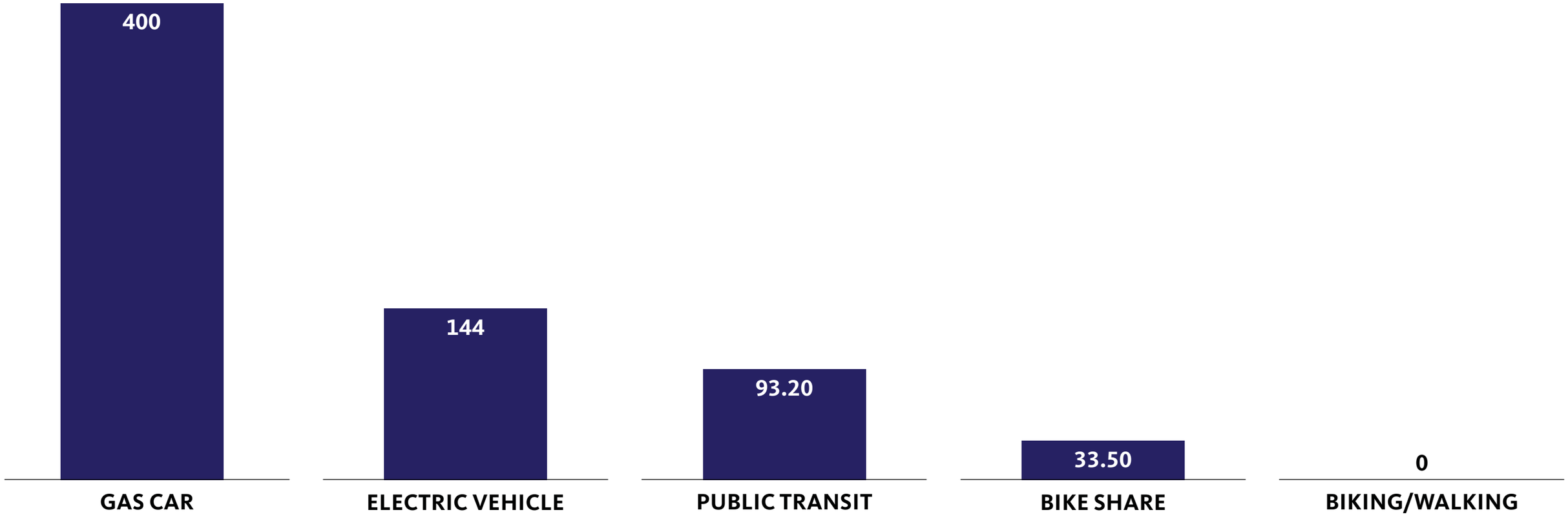
Percentage of workers commuting by each form of transportation in each city.



Switching from a gas car to public transit dramatically reduces carbon emissions.

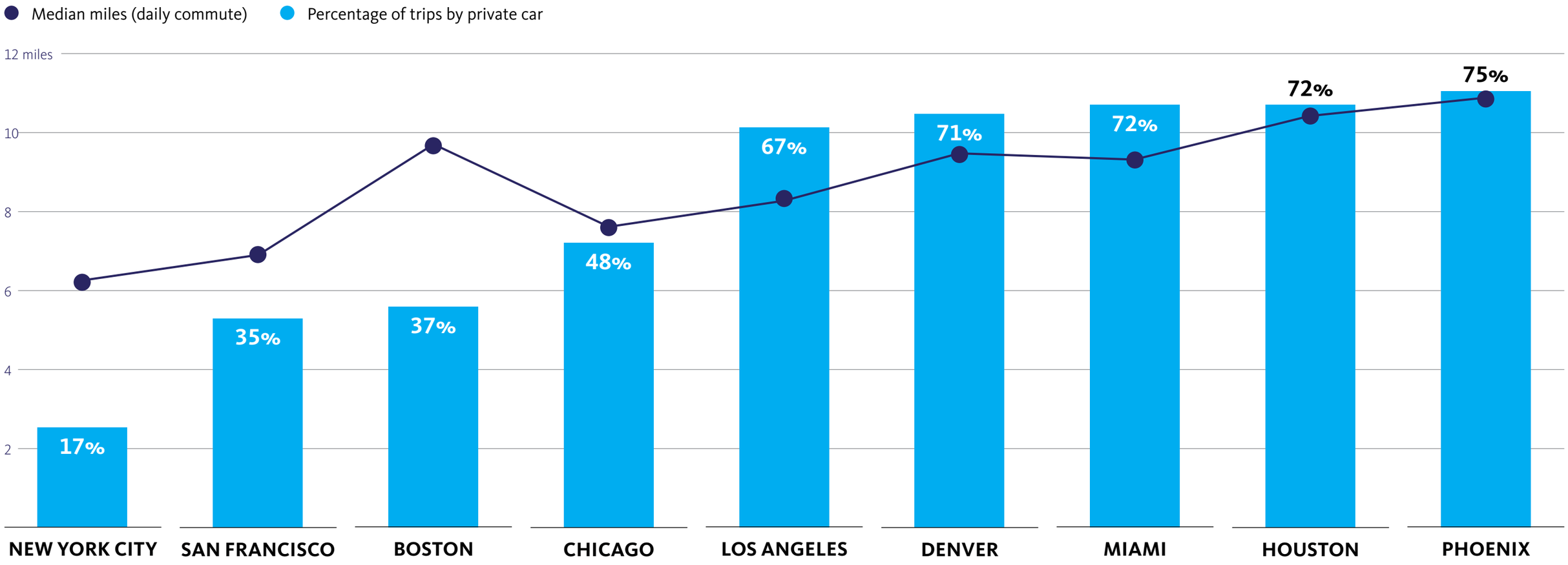
Cars are by far the most carbon-intensive way to commute.

Average carbon emissions per mile in the U.S. (grams CO_2).



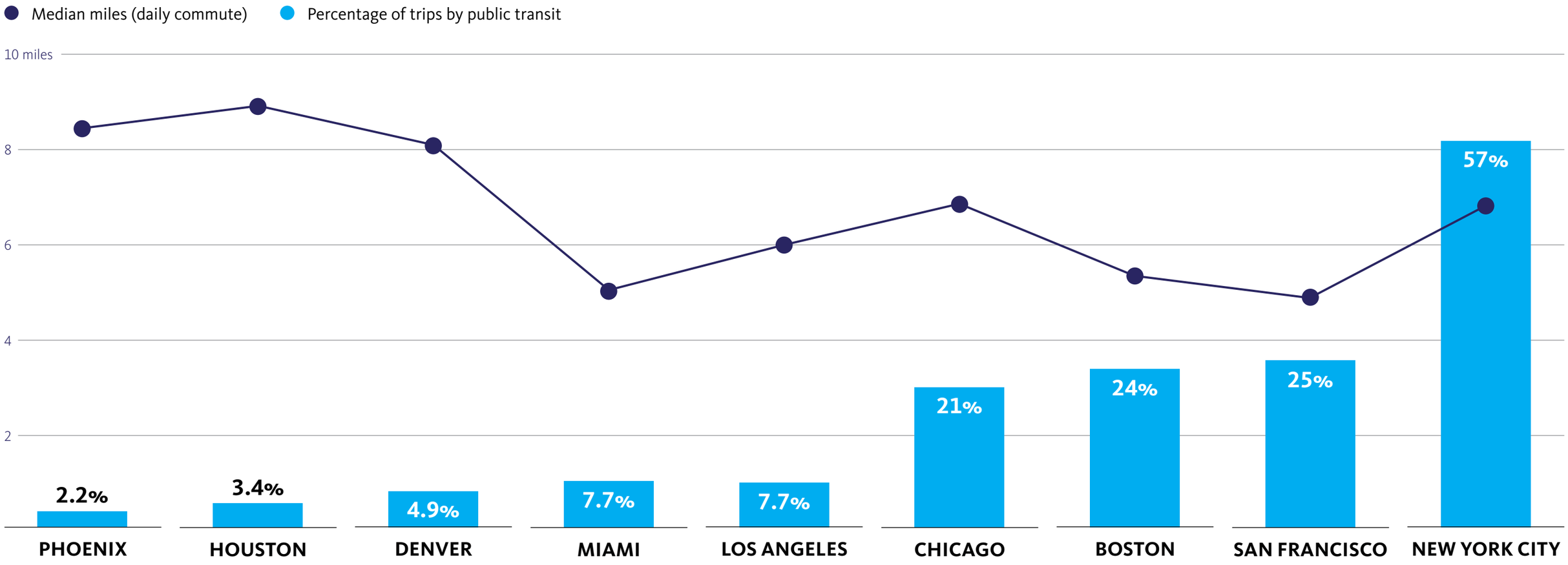
Longer commutes are more likely to be taken by car.

The median daily miles traveled in a one-way trip compared to the percentage of trips taken by private car in nine U.S. cities.



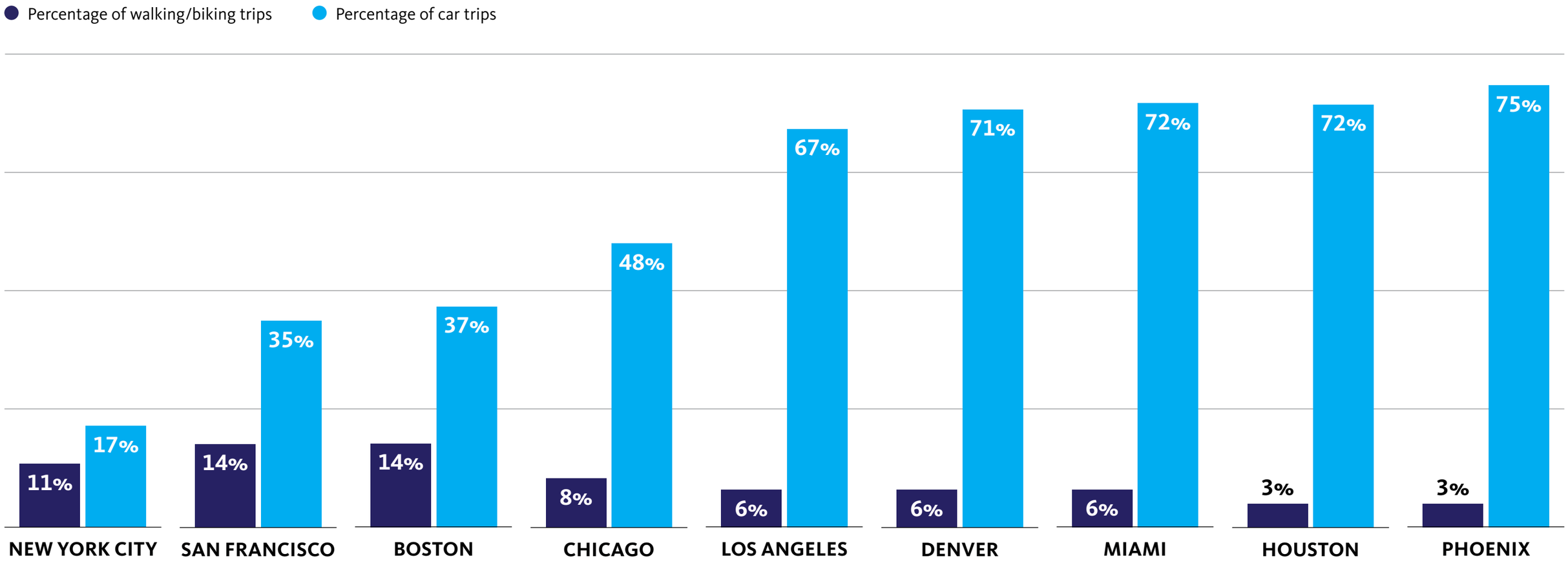
Commute distances are shorter in transit-rich cities.

The median daily miles traveled in a one-way trip compared to the percentage of trips taken by public transit in nine U.S. cities.



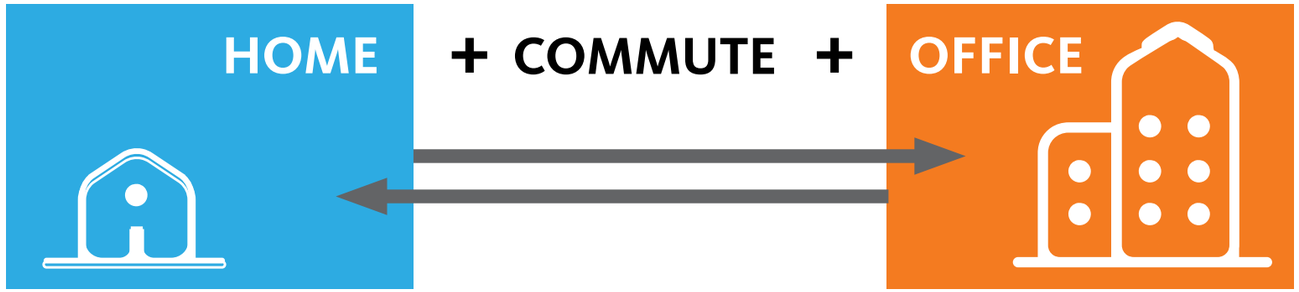
Walking and biking is inversely correlated with car commutes in all cities.

The percentage of trips taken by walking or biking compared to the percentage taken by private car in nine U.S. cities.



CALCULATING
WORKDAY CARBON

Our Approach to Calculating the Carbon Impact of Work



Typical Workday Scenarios

1 WORK FROM OFFICE
No home setback

Home	**FULLY OPERATIONAL**
Commute	**YES**
Office	**FULLY OPERATIONAL**

2 WORK FROM OFFICE
Mild home setback

Home	**SYSTEMS SETBACK 30%**
Commute	**YES**
Office	**FULLY OPERATIONAL**

3 WORK FROM OFFICE
Aggressive home setback

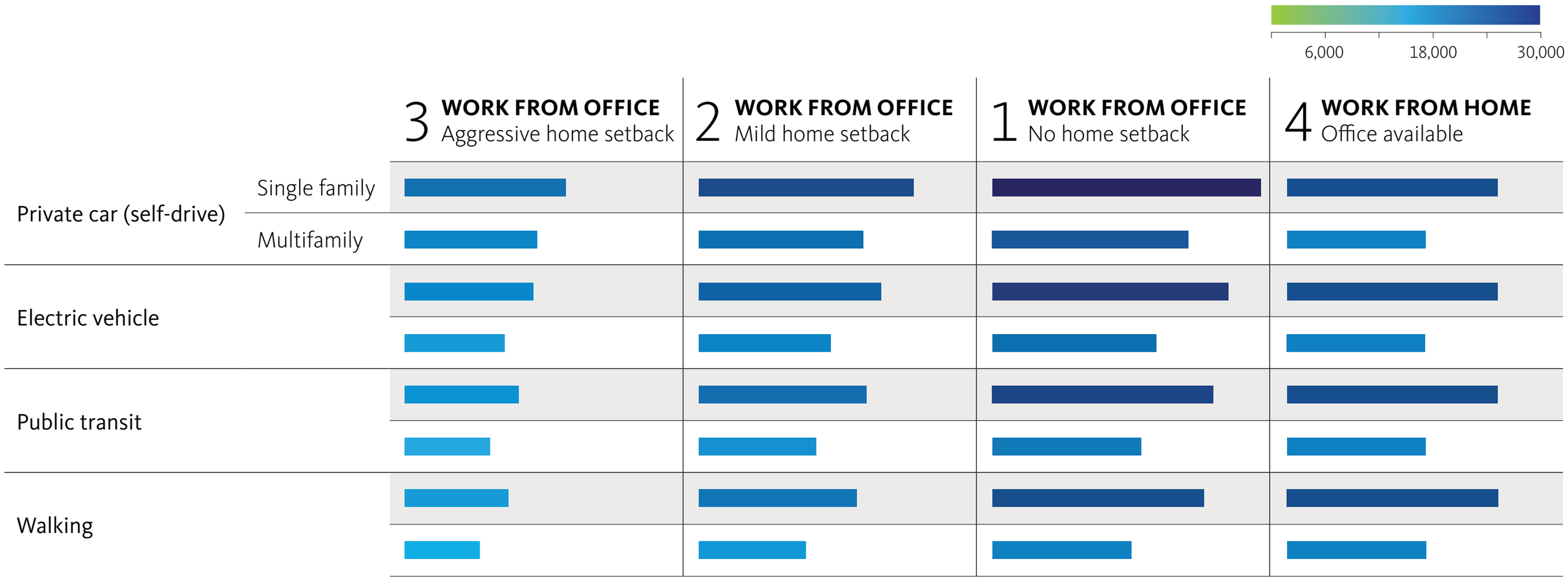
Home	**SYSTEMS SETBACK 60%**
Commute	**YES**
Office	**FULLY OPERATIONAL**

4 WORK FROM HOME
No office setback

Home	**FULLY OPERATIONAL**
Commute	**NO**
Office	**FULLY OPERATIONAL**

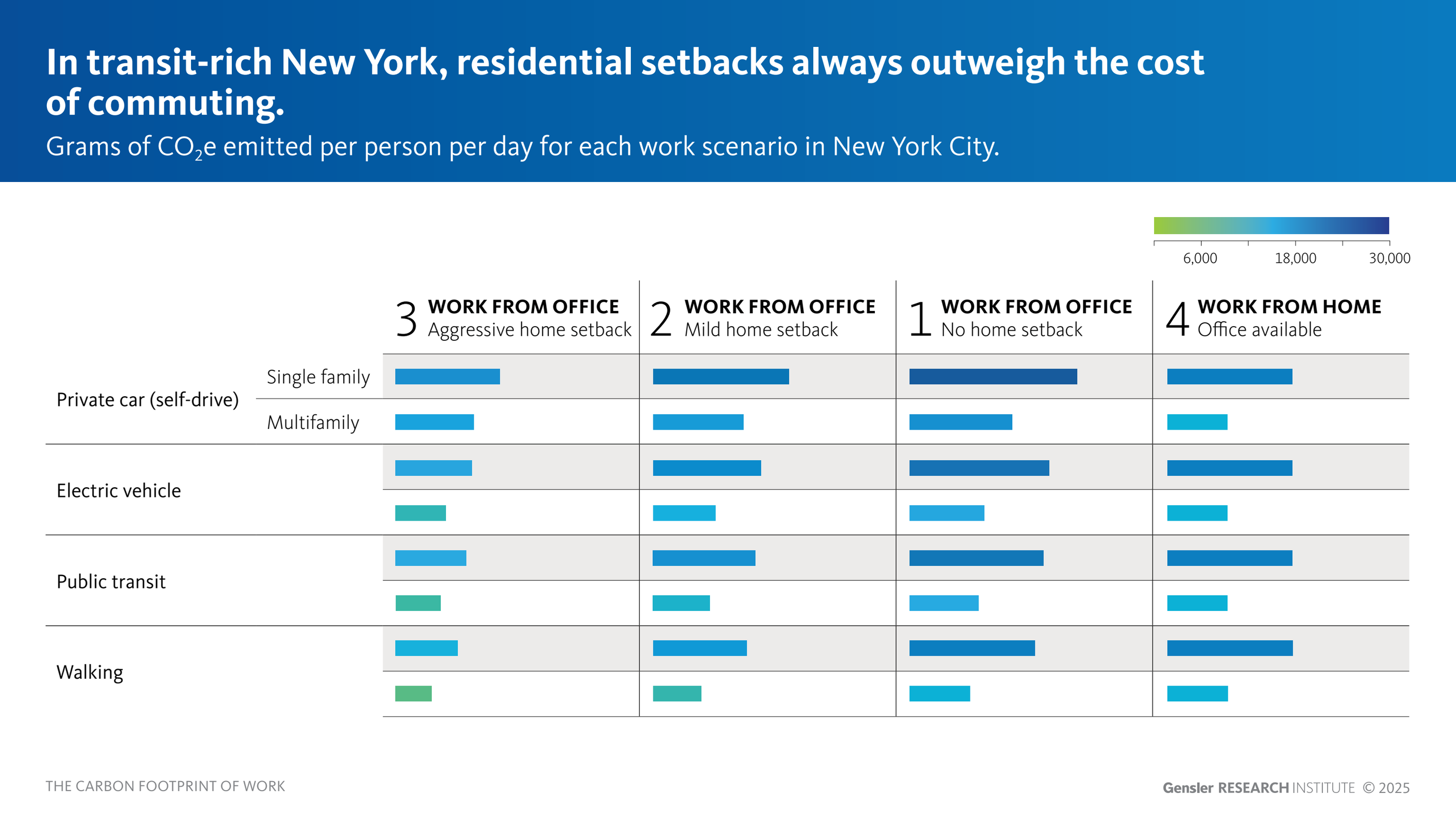
In Chicago, a dirty grid and cold climate drive up emissions.

Grams of CO_2e emitted per person per day for each work scenario in Chicago.



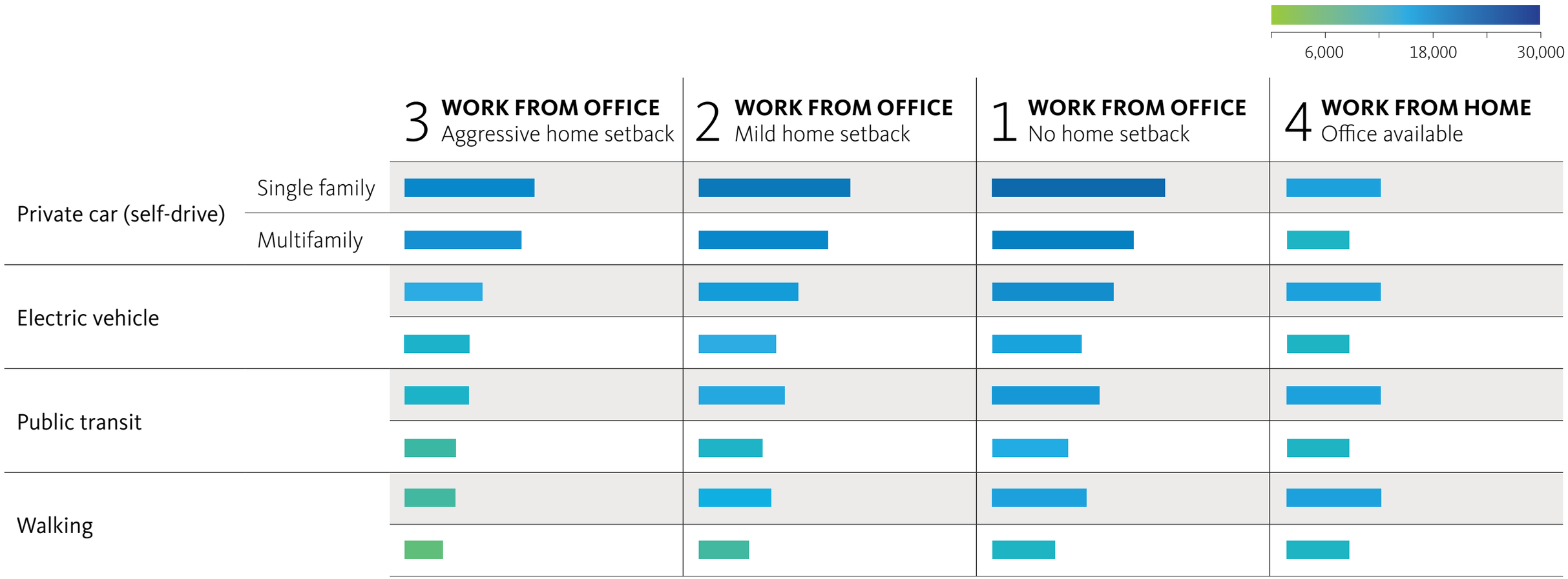
In transit-rich New York, residential setbacks always outweigh the cost of commuting.

Grams of CO_2e emitted per person per day for each work scenario in New York City.



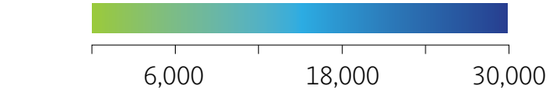
In sprawling Houston, avoiding gas car commutes is most effective to reducing emissions.

Grams of CO_2e emitted per person per day for each work scenario in Houston.



In San Francisco, a cleaner grid keeps emissions lower in all scenarios.

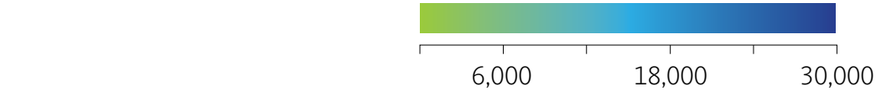
Grams of CO_2e emitted per person per day for each work scenario in San Francisco.



		3 WORK FROM OFFICE Aggressive home setback	2 WORK FROM OFFICE Mild home setback	1 WORK FROM OFFICE No home setback	4 WORK FROM HOME Office available
Private car (self-drive)	Single family				
	Multifamily				
Electric vehicle					
Public transit					
Walking					

In LA, long car commutes and a clean energy grid open the door to effective EV adoption.

Grams of CO_2e emitted per person per day for each work scenario in Los Angeles.



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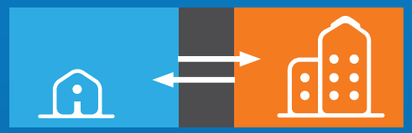


KEY TAKEAWAYS

Key Takeaways

Leverage shared infrastructure to reduce workday carbon emissions.

Multifamily homes are more efficient than single-family homes.

Offices are more efficient workspaces than homes.

Public transit is more efficient than driving.

Key Takeaways

Local climate and electric grid play significant roles.

Where electricity is more dependent on fossil fuels, the same lifestyle produces higher emissions.

Key Takeaways

Setbacks help maximize savings in dense cities with dirty grids.

Individuals should employ aggressive home setbacks, while organizations can use office setbacks for hybrid workweeks.

Key Takeaways

In cities with long commutes, choose public transit or reduce travel distance.

Even the most aggressive home setbacks can't offset long-haul car commutes.

Research Applications

DESIGN

- Select office sites with access to public transit
- Incorporate on-site renewable energy generation
- Integrate smart energy systems in homes and offices
- Prioritize dense multifamily development
- Redesign streets to accommodate walking and biking

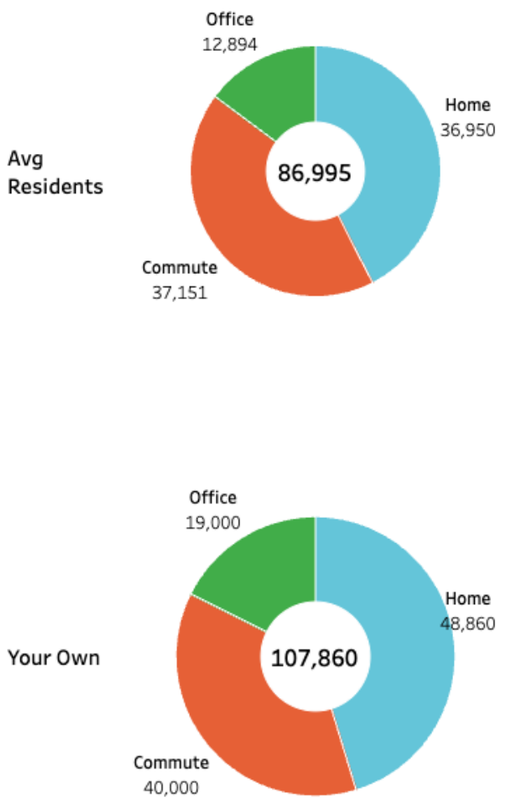
POLICY

- Update energy grids to reduce fossil fuel reliance
- Expand public transit networks to more population centers
- Ensure workers are “all-in” or “all-out” of the office to reduce redundancies
- Re-zone areas around transit nodes to encourage development
- Incentivize EV charging stations over gas stations in cities with clean grids

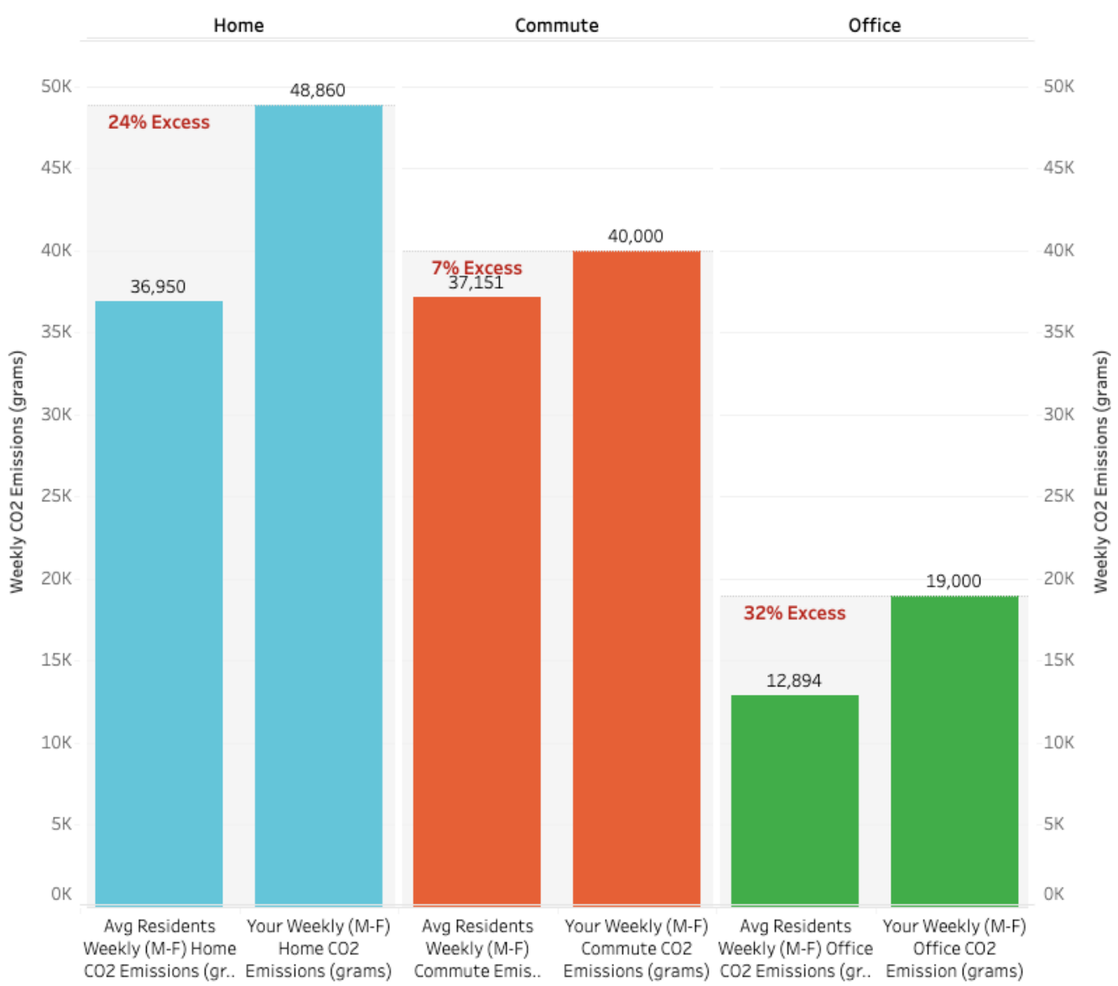
GENSLER, LOS ANGELES

Personal Workweek Carbon Calculator

Total Weekly CO2 Emissions (grams)



Weekly Emissions Breakdown by Category



Your Home

City
- Boston
- Chicago
- Denver
- (•) Houston
- Los Angeles
- Miami
- New York
- Phoenix
- San Francisco

Residence Type
- Apartment in multi-family building
- (•) Single-family house

Residence Vintage
- (•) New
- Old

Household Size
3

Residence Size (sq. ft)
2,000

Residence Heating
- (•) Electric
- Heat Pump
- Natural Gas Furnace

Home Heating & Cooling
- (•) Always on
- Reduced while I'm at work
- Turned off while I'm at work

Your Commute

Primary Mode
- (•) Car Passenger
- e-scooter/Bikeshare
- Private Car (electric)
- Private Car (gasoline)
- Public Transit
- Walking/Own Bike

Commute (1-way miles)
10

Your Office

Days in Office
5

Office Building Vintage
- (•) New
- Old

Workspace Type
- (•) Assigned office
- Assigned workstation
- Unassigned workstation
- None

Office Heating
- (•) Electric
- Heat Pump
- Natural Gas Furnace

Mobility Initiative

Gensler