SOUTHEAST FLORIDA REGIONAL CLIMATE CHANGE COMPACT

SOUTHEAST FLORIDA COMMUNITY-WIDE GREENHOUSE GAS INVENTORY

2019 AND 2021

ACKNOWLEDGEMENTS

The data and analysis in this report were produced for the Southeast Florida Regional Climate Change Compact by ICLEI Local Governments for Sustainability USA. ICLEI USA is a national non-profit that assists local governments with all aspects of sustainability and climate analysis and action.

Contents

(continue next page)

Contents (continued)

List of Tables

List of Figures

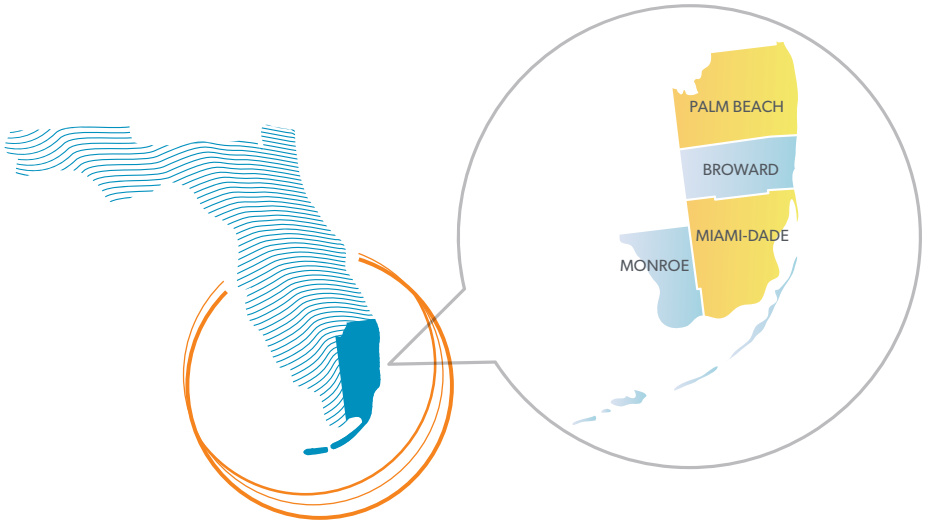
INTRODUCTION

The Southeast Florida Regional Climate Change Compact aims to foster sustainability and climate resilience at a regional scale. Through the establishment of the Compact in 2009, Broward, Miami-Dade, Monroe, and Palm Beach Counties committed to collaborate on strategies to reduce the region's emissions, including the development of an emissions baseline for Southeast Florida. The Compact is in the process of developing a regional greenhouse gas reduction plan through the Environmental Protection Agency's Climate Pollution Reduction Grant, which will be complete in December 2025. A regional greenhouse gas emissions (GHG) inventory is integral to developing informed emissions reduction strategies, providing a baseline against which local governments can compare future performance and monitor the region's progress over time.

The Compact previously conducted an inventory of regional emissions from 2005 to 2015. However, the scope was limited to systems at the regional scale, including transportation (on-road transportation, passenger rail, and freight rail) and stationary energy from residential, commercial, and industrial buildings, making comparisons between the results of this inventory and the previous inventory difficult.

REGIONAL CONTEXT

The Compact region consists of Broward, Miami-Dade, Monroe, and Palm Beach Counties, 109 municipalities, and the Miccosukee and Seminole Tribes in Southeast Florida. In 2021, this region was home to an estimated 6,191,491 people and generated hundreds of billions of dollars in annual economic activity.



Southeast Florida also has a robust network of airports and ports, serving as crucial transportation and logistics hubs. Key airports include Miami International Airport (MIA), Fort Lauderdale-Hollywood International Airport (FLL), Palm Beach International Airport (PBI), and Key West International Airport (EYW). Major seaports include Port Everglades (Fort Lauderdale), Port of Miami (Miami), Port of Palm Beach (Riviera Beach), and the Port of Key West (Key West).

The two years covered by this GHG inventory report, 2019 and 2021, represent the year prior to the COVID-19 pandemic and the second year of the pandemic, respectively. Many of the social and economic impacts resulting from the pandemic undoubtedly reduced greenhouse gas emissions temporarily, but these effects were short-lived and failed to drive lasting change. While remote work led to domestic in-migration in many parts of Florida during the COVID-19 pandemic, those trends did not manifest in Southeast Florida until later years. Regional population in the four-county region actually decreased between 2019 and 2021, with declines in Broward and Miami-Dade Counties outweighing slight increases in Monroe and Palm Beach Counties.

INVENTORY SCOPE

This regional greenhouse gas inventory report provides a summary of emissions trends across Broward, Miami-Dade, Monroe and Palm Beach Counties for 2019 and 2021, inclusive of commercial, residential, and industrial stationary energy; transportation and mobile sources; solid waste; water and wastewater; and agriculture and land use. The regional inventory is an assessment of community-wide emissions of predominant major greenhouse gases: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O); and also includes emissions of sulfur hexafluoride (SF_6), hydrofluorocarbons, and perfluorocarbons.

The major sectors covered by this inventory are:

Transportation	» Gasoline and diesel consumed by on-road transportation » Diesel consumed by rail » Diesel consumed by commercial marine vehicles » Jet fuel loaded at major airports » All types of fuels consumed by other non-road transportation activities
Stationary Energy	» Residential, commercial, and industrial buildings' consumption of: › Electricity › Natural gas › Non-utility fuels
Solid Waste	» Emissions generated by combusted and landfilled municipal solid waste
Wastewater	» Biochemical emissions generated during wastewater processing
Agriculture, Forestry, and Other Land Use (AFOLU)	» Emissions associated with land use changes » Biochemical emissions from: › Growing rice and legumes › Application of nitrogen fertilizer › Oxidation of muck soils
Process and Fugitive Emissions	» Emissions from leakage or use of: › refrigerants › fire suppressants › aerosols solvents › SF_6 in electrical transformers » Process emissions from facilities producing cement

METHODOLOGY OVERVIEW

This inventory generally follows the accounting guidance in the U.S. Protocol for Community-Scale Greenhouse Gas Emissions Inventories, published by ICLEI. This protocol is specifically geared toward conducting a GHG emissions inventory at the community scale in the United States and attempts to include the majority of emissions from sources within the geographical boundary of the community (excluding electrical power generation), as well as the emissions associated with all electricity usage within the community, even if that electricity is generated outside of the community. The charts and graphs presented generally provide emissions in "carbon dioxide equivalent" (CO_2e) values, calculated using the Intergovernmental Panel on Climate Change (IPCC) 5th Assessment, 100-year values for global warming potentials (GWP). Calculations were made using ICLEI's ClearPath software. Refer to the detailed methodology section for more information on the methodology and data sources used to develop this inventory.

EMISSIONS SNAPSHOT FOR SOUTHEAST FLORIDA

Over the two-year period covered by this inventory, the region demonstrated a 7.4% decrease in overall emissions, while population declined less than 1.0% and gross domestic product increased 6.5%.

		2019	2021	% CHANGE
Community-wide regional emissions (metric tons of carbon dioxide (CO_2) equivalent ($MtCO_2e$)		75,087,581	69,518,369	-7.417%
Population[1]		6,240,716	6,191,491	-0.789%
Per capita emissions ($MtCO_2e$)		12.032	11.228	-6.681%
Economic output (in chained 2017 $)[2]		$372,839,550,000	$396,969,413,000	6.472%
Largest contributors to emissions	Transportation: 50% *Including on-road vehicles, airports, marine vessels, and other off-road vehicles*		Transportation: 48%	n/a
	Commercial buildings: 14% *Including electricity, natural gas, and other fuels used by commercial buildings*		Commercial buildings: 14%	n/a
	Residential buildings: 14% *Including electricity, natural gas, and other fuels used by residential buildings*		Residential buildings: 15%	n/a

1 US Census Bureau, Annual Estimates of the Resident Population for Counties in Florida: April 1, 2010 to July 1, 2019 and April 1, 2020 to July 1, 2024.

2 Bureau of Economic Analysis, Regional Economic Accounts, GDP Summary by County and MSA, https://apps.bea.gov/regional/zip/CAGDP1.zip

REGIONAL EMISSIONS AT A GLANCE

2019

1 **TRANSPORTATION & MOBILE SOURCES**
49.8%

2 **COMMERCIAL ENERGY**
14.0%

3 **RESIDENTIAL ENERGY**
13.5%

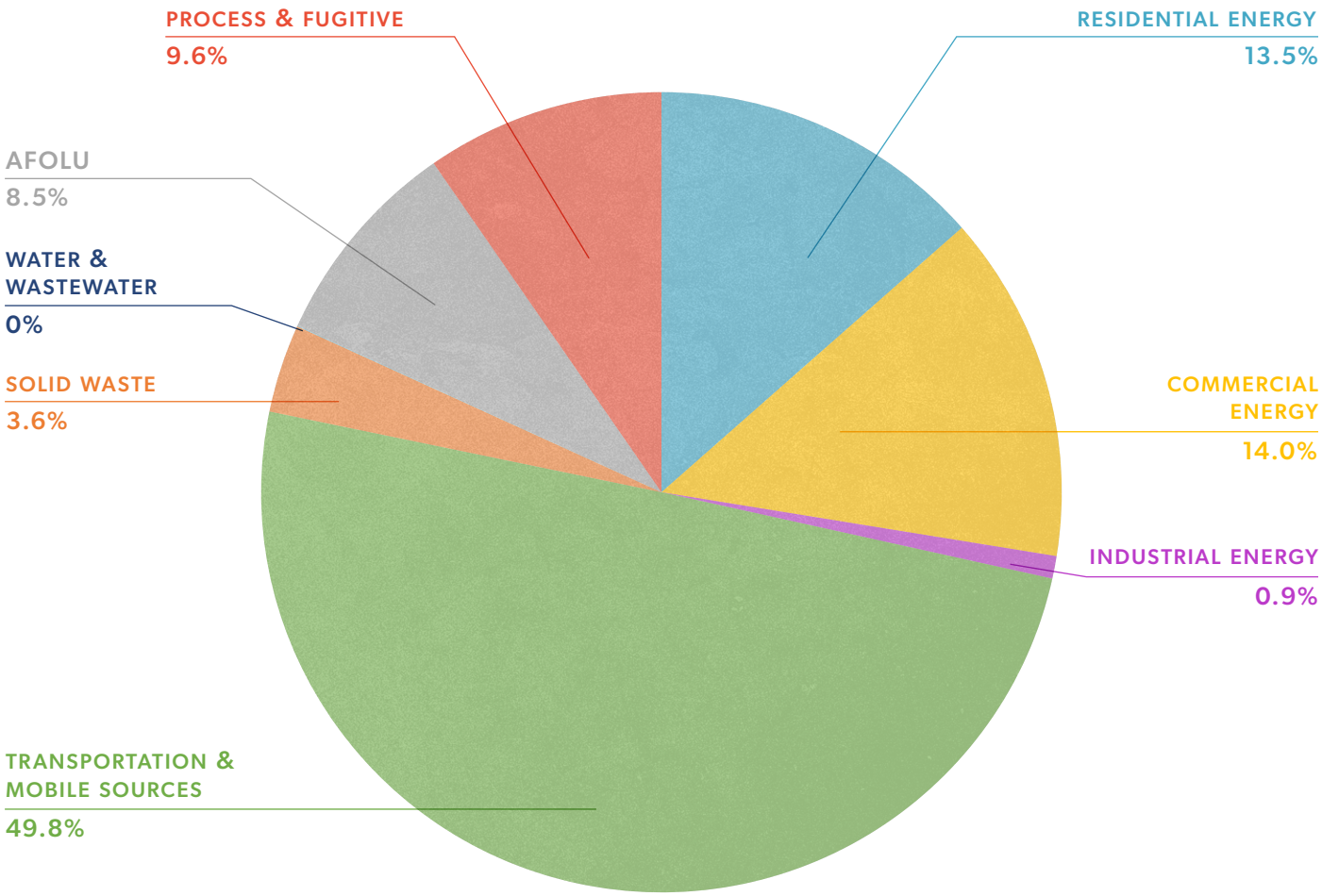


FIGURE 1: 2019 Emissions by Sector for the Compact Region

2021

1 **TRANSPORTATION & MOBILE SOURCES**
47.5%

2 **RESIDENTIAL ENERGY**
14.6%

3 **COMMERCIAL ENERGY**
14.1%

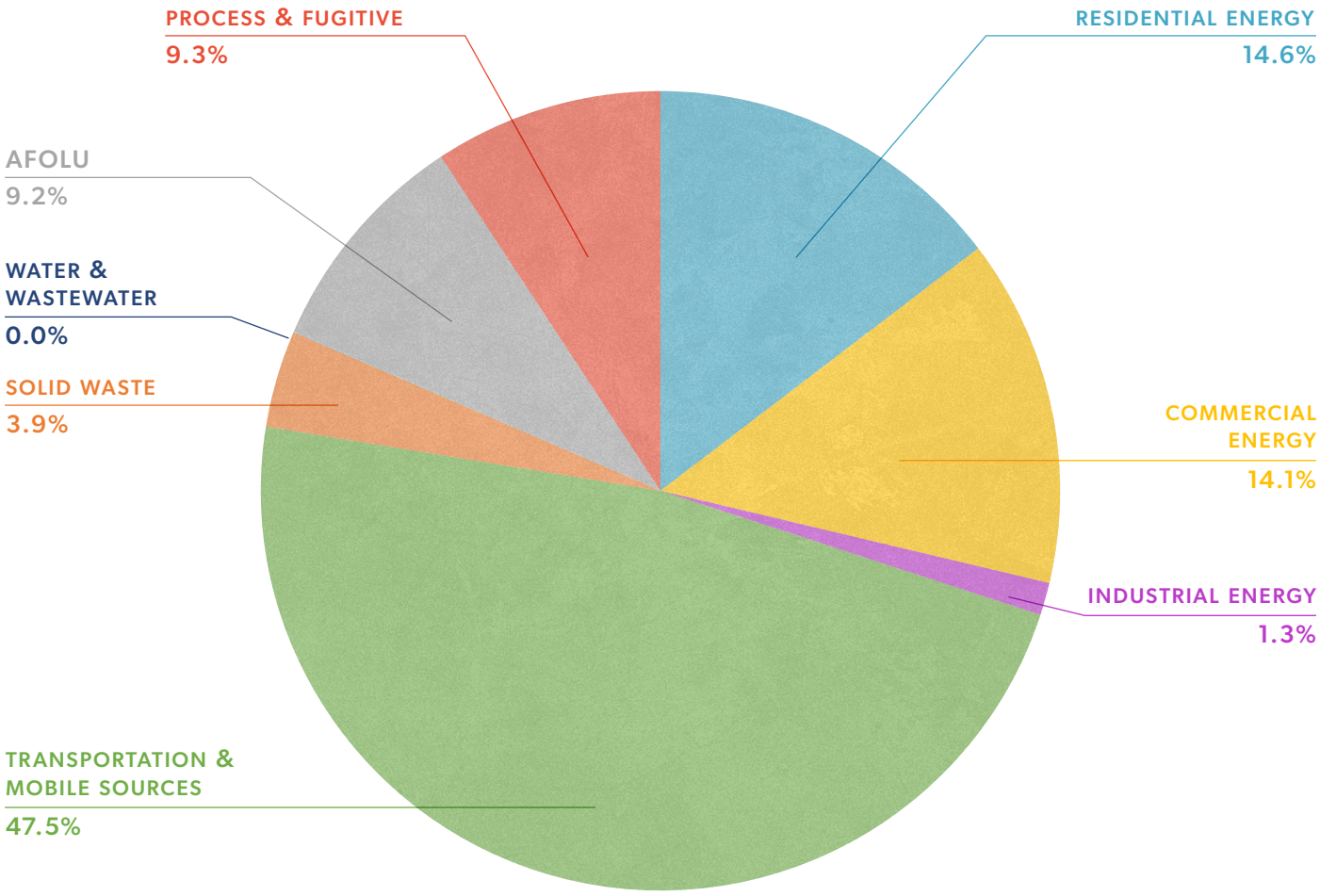


FIGURE 2: 2021 Emissions by Sector for the Compact Region

FIGURE 3: Total Emissions by County and Region

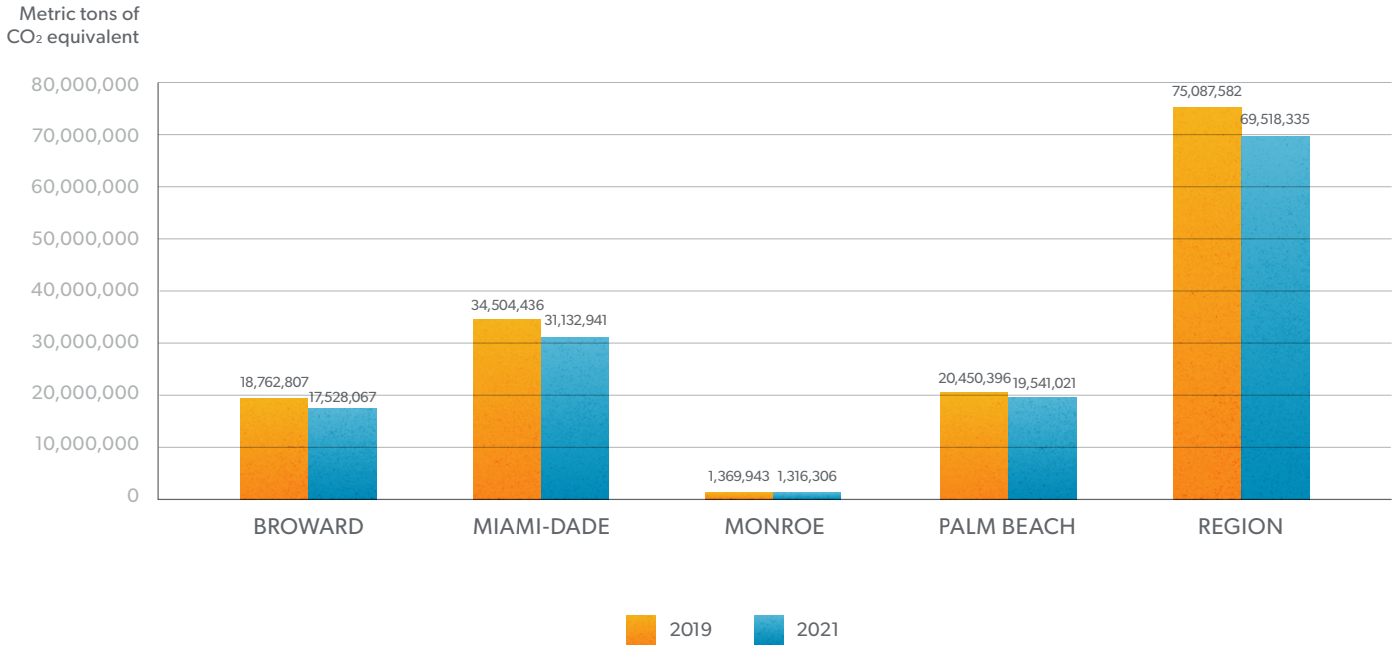


FIGURE 4: Total Emissions Per Capita by County and Compact Region

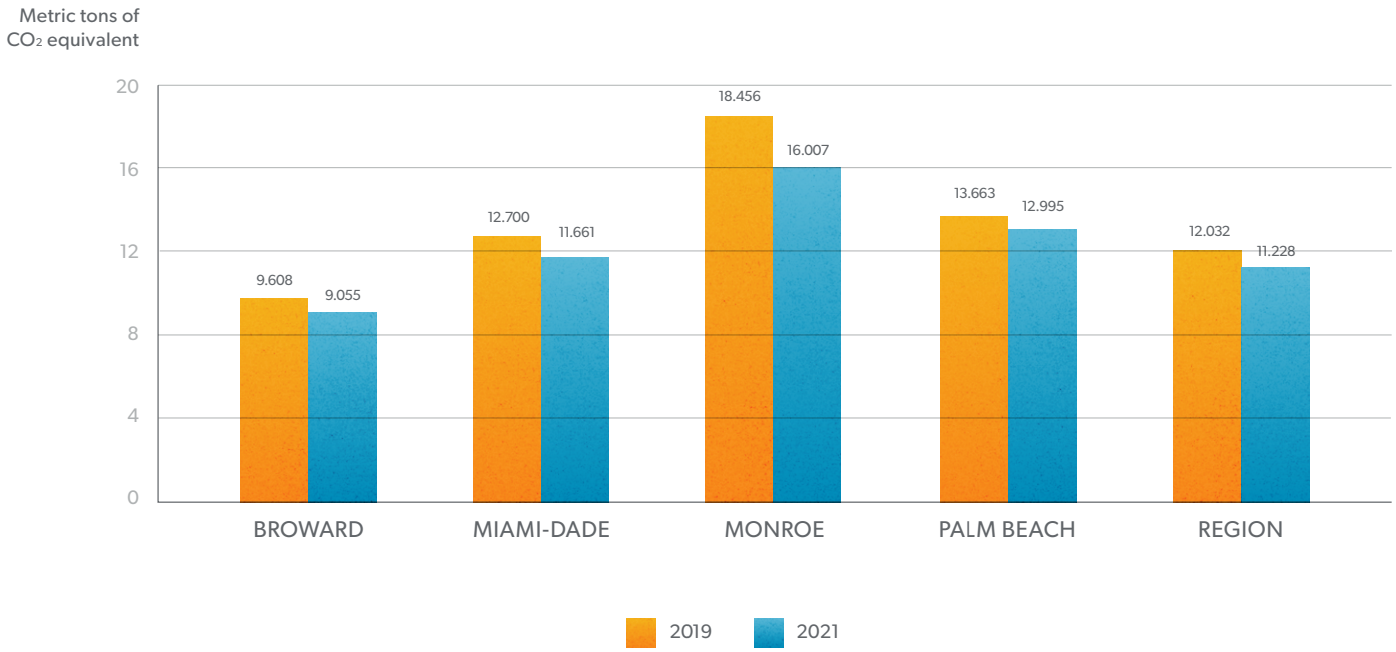


FIGURE 5: Population vs. Total Emmisions vs. Per Capita Emissions vs. GDP

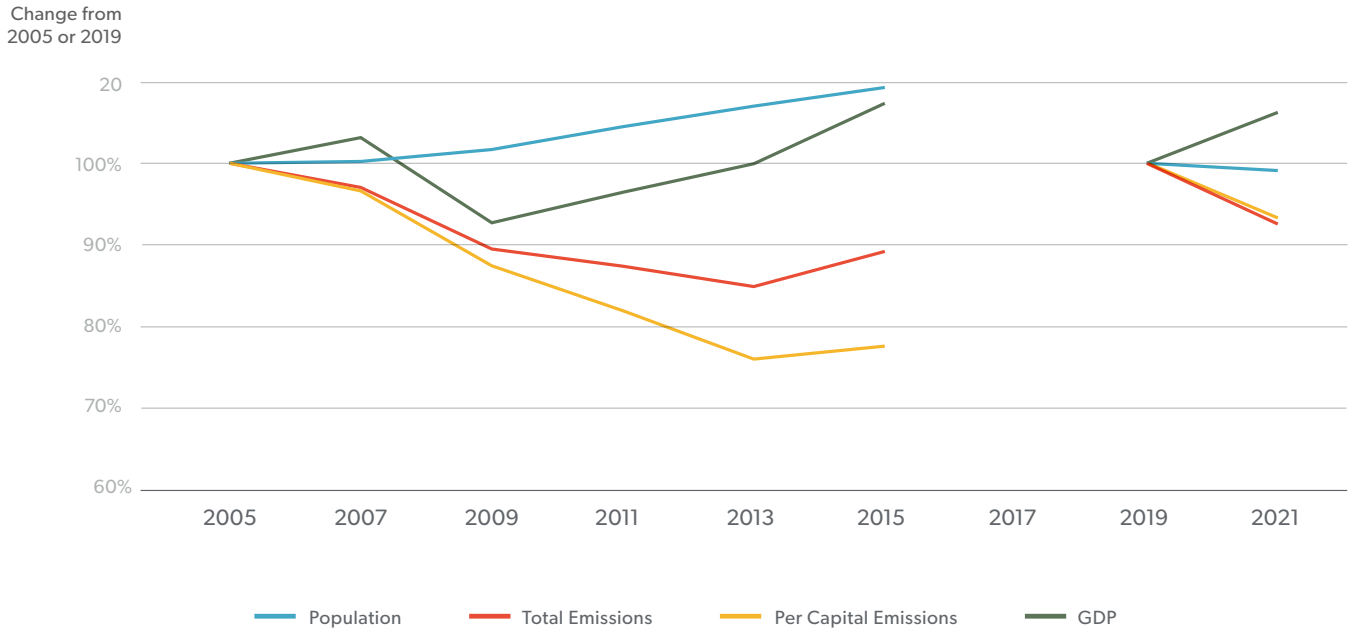


Figure 5 draws from the Compact's previous GHG Emissions Inventory, as well as U.S. Census Bureau and Bureau of Economic Analysis data, to chart the relative change over time in total Compact region emissions, emissions per capita, population, and economic output. Initial values in each category in 2005 were set at 100%, and the change in values charted for each category in a given year compared to the initial year.

Given the significant differences between the current inventory and previous inventory scope and methodology, the trend comparison is not continuous. A new trendline is established in 2019, with the values for that year assigned 100% values, and the change in values charted for 2021.

The trends in each of the two series are similar: total emissions and per capita emissions decline over time, while population and economic output increase. This decoupling of emissions from population and economic growth is a global phenomenon, demonstrating that changes in technology and lifestyles are successfully reducing emissions.

COMMUNITY EMISSIONS INVENTORY RESULTS

Community-wide emissions for the Compact region and individual counties are shown in Figures 6–10.

FIGURE 6: Compact Region Emissions by Sector

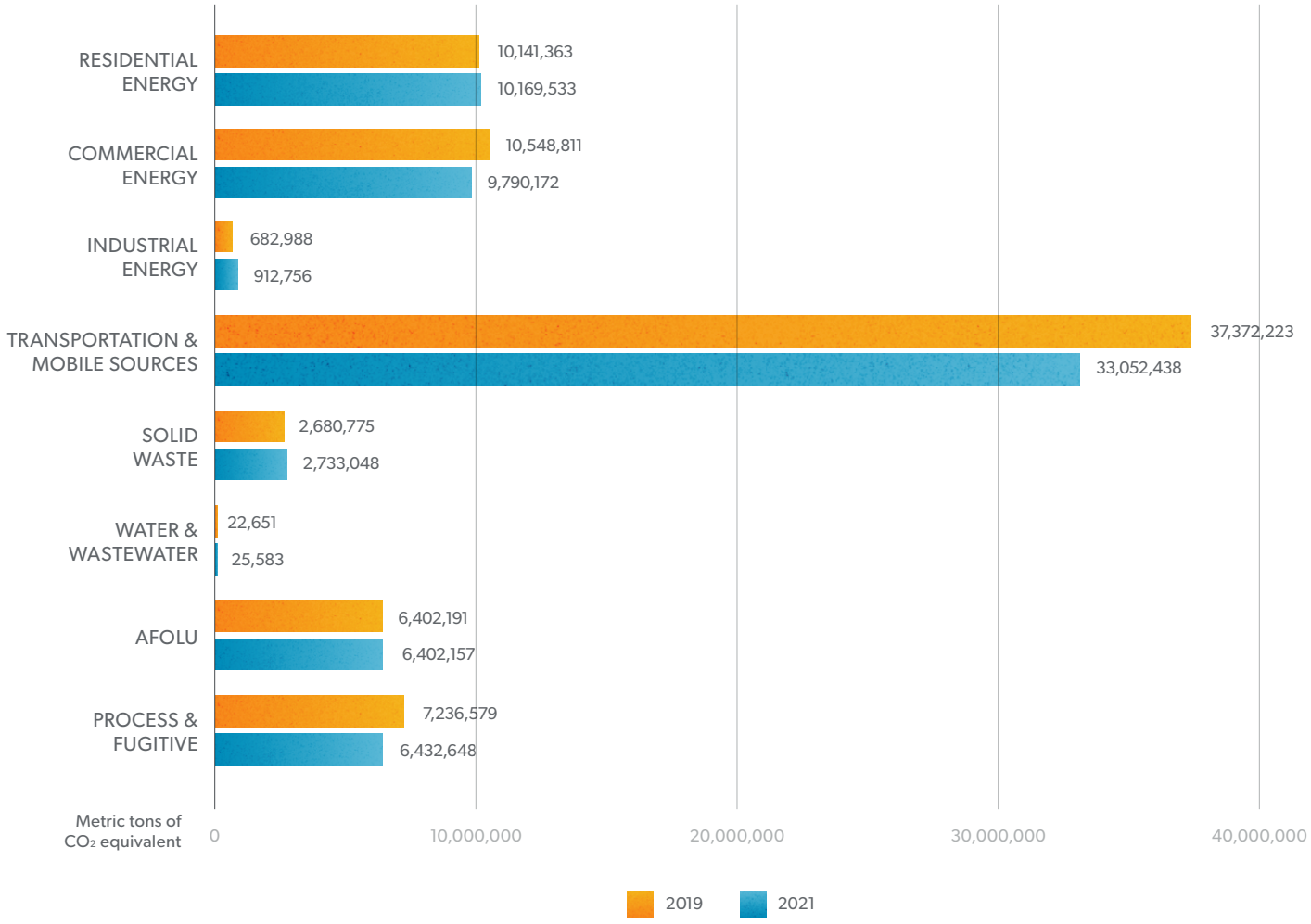


Figure 6 shows the distribution of Compact region community-wide emissions by sector. Transportation is the largest contributor, followed by commercial and residential energy.

FIGURE 7: Broward County Emissions by Sector

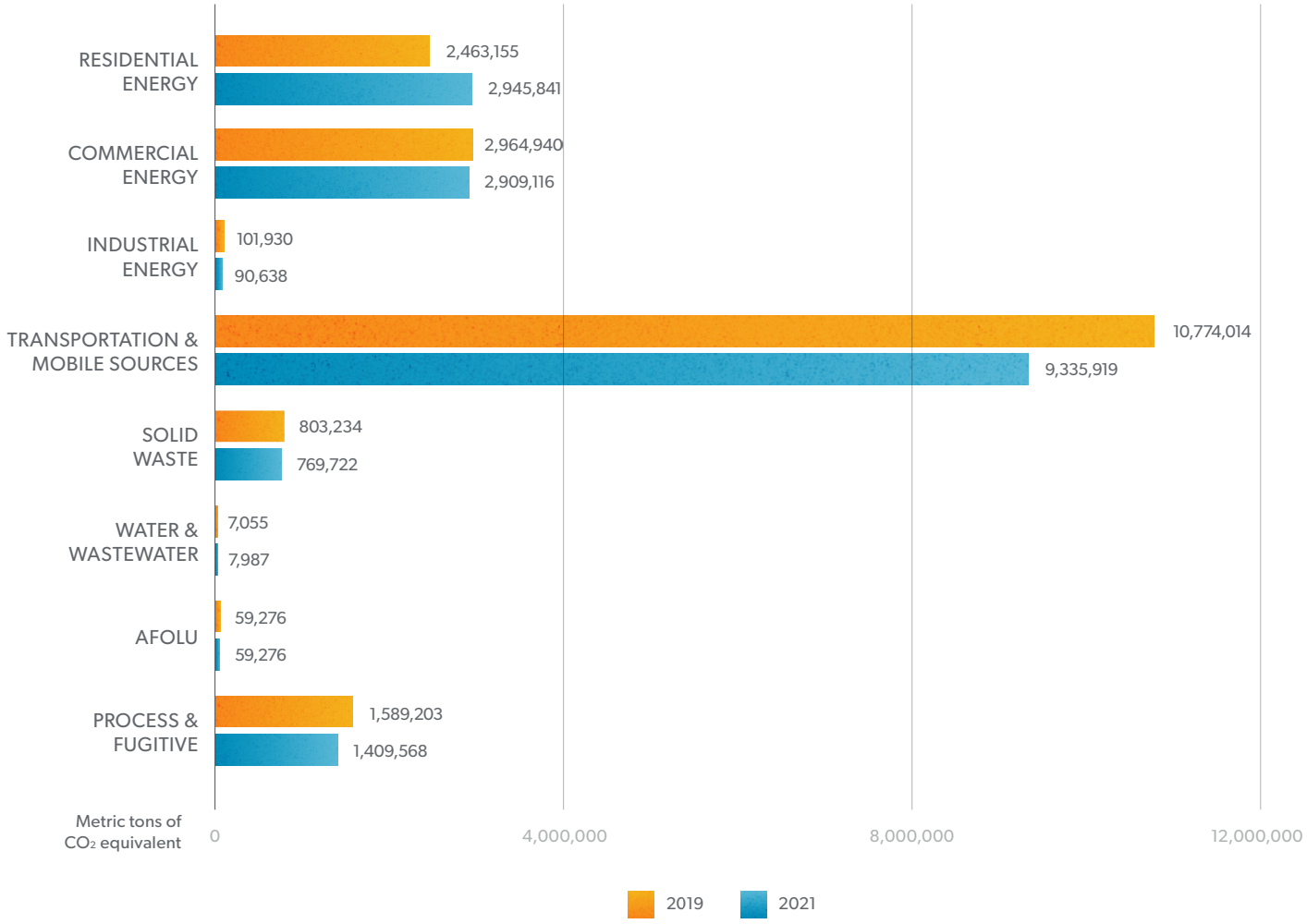


Figure 7 shows the distribution of Broward County community-wide emissions by sector in 2019 and 2021. Transportation is the largest contributor, followed by commercial and residential energy.

FIGURE 8: Miami-Dade County Emissions by Sector

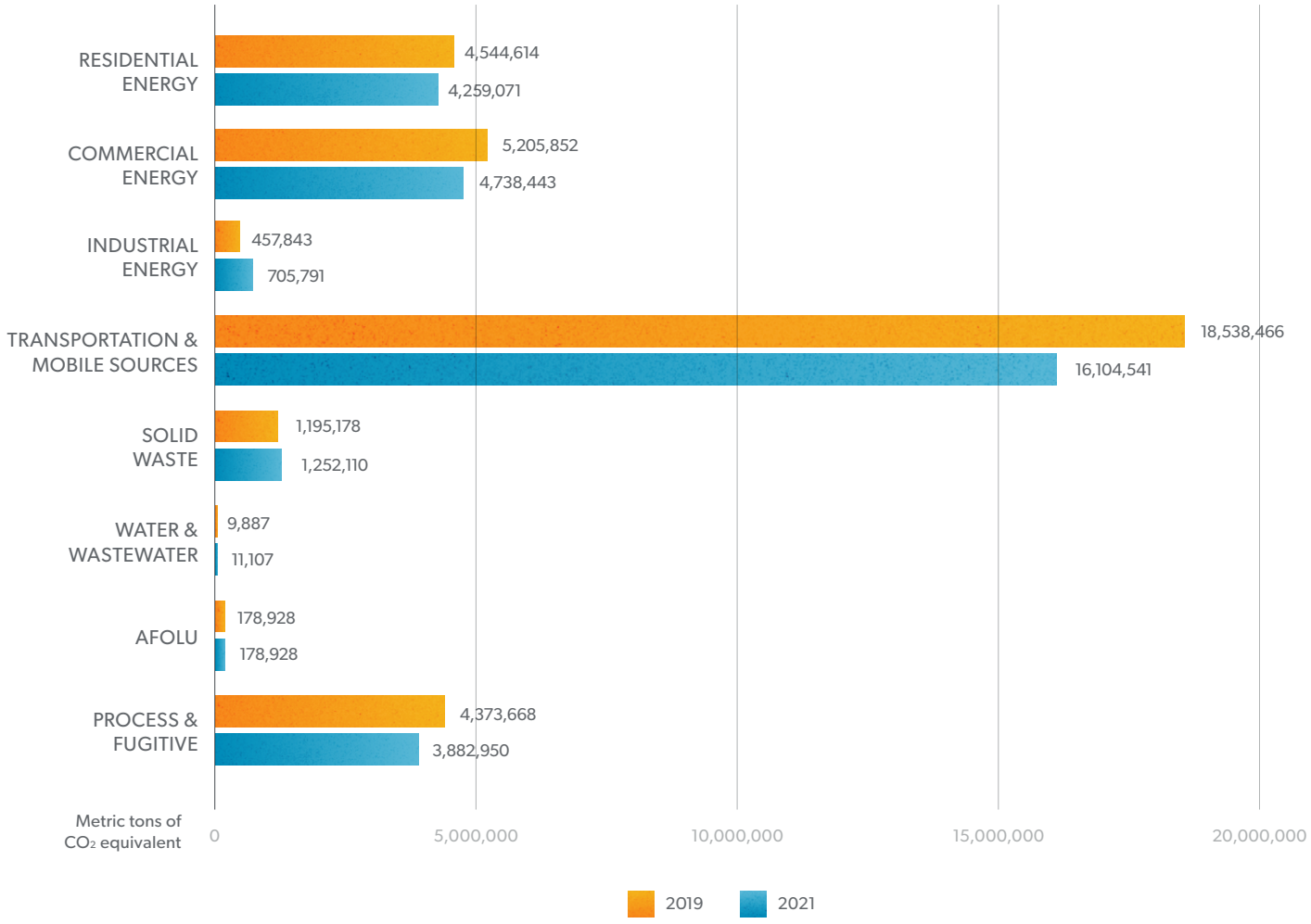


Figure 8 shows the distribution of Miami-Dade County community-wide emissions by sector for 2019 and 2021. Transportation is the largest contributor, followed by commercial and residential energy.

FIGURE 9: Monroe County Emissions by Sector

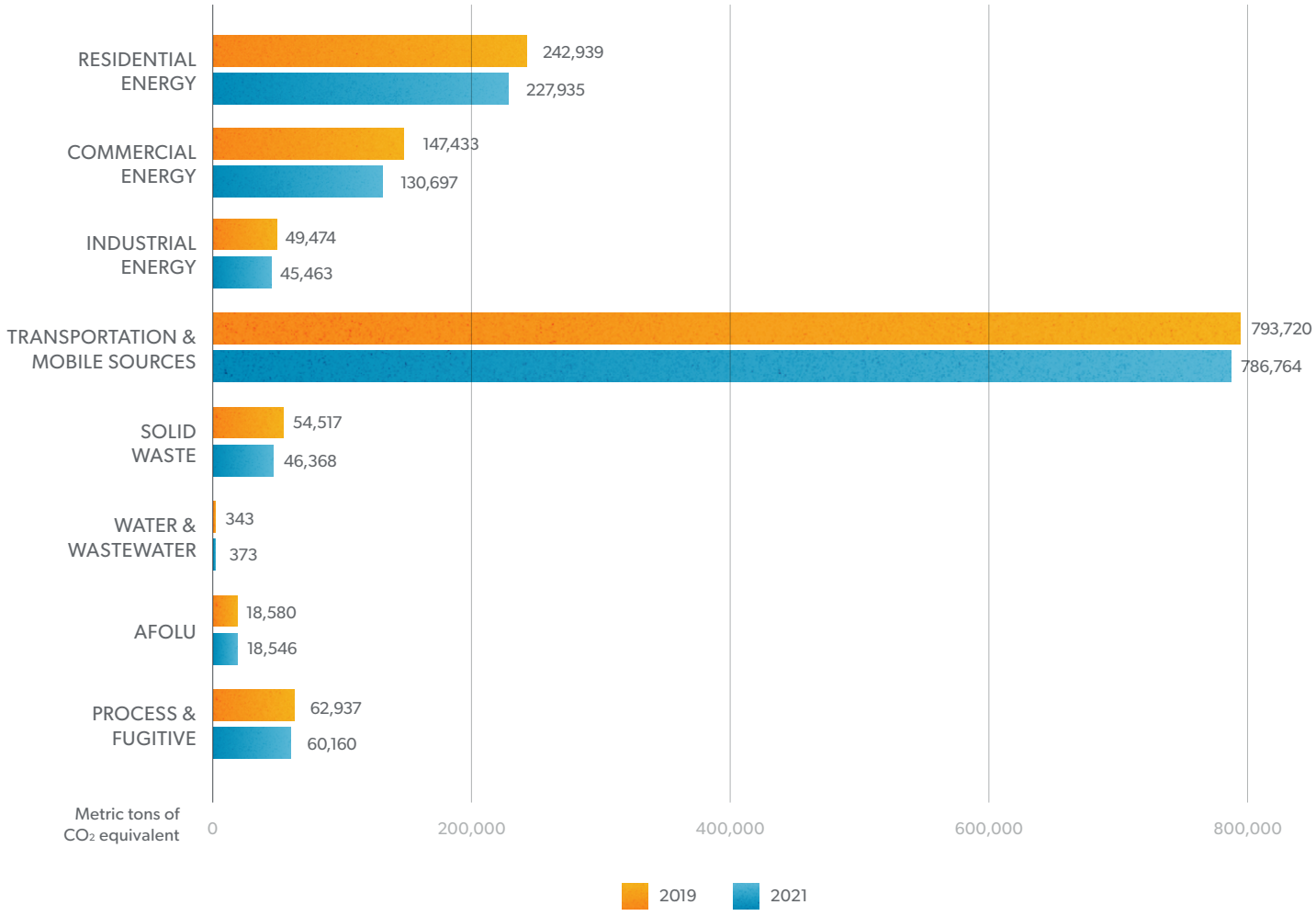


Figure 9 shows the distribution of Monroe County community-wide emissions by sector. Transportation is the largest contributor, followed by residential and commercial energy.

FIGURE 10: Palm Beach County Emissions by Sector

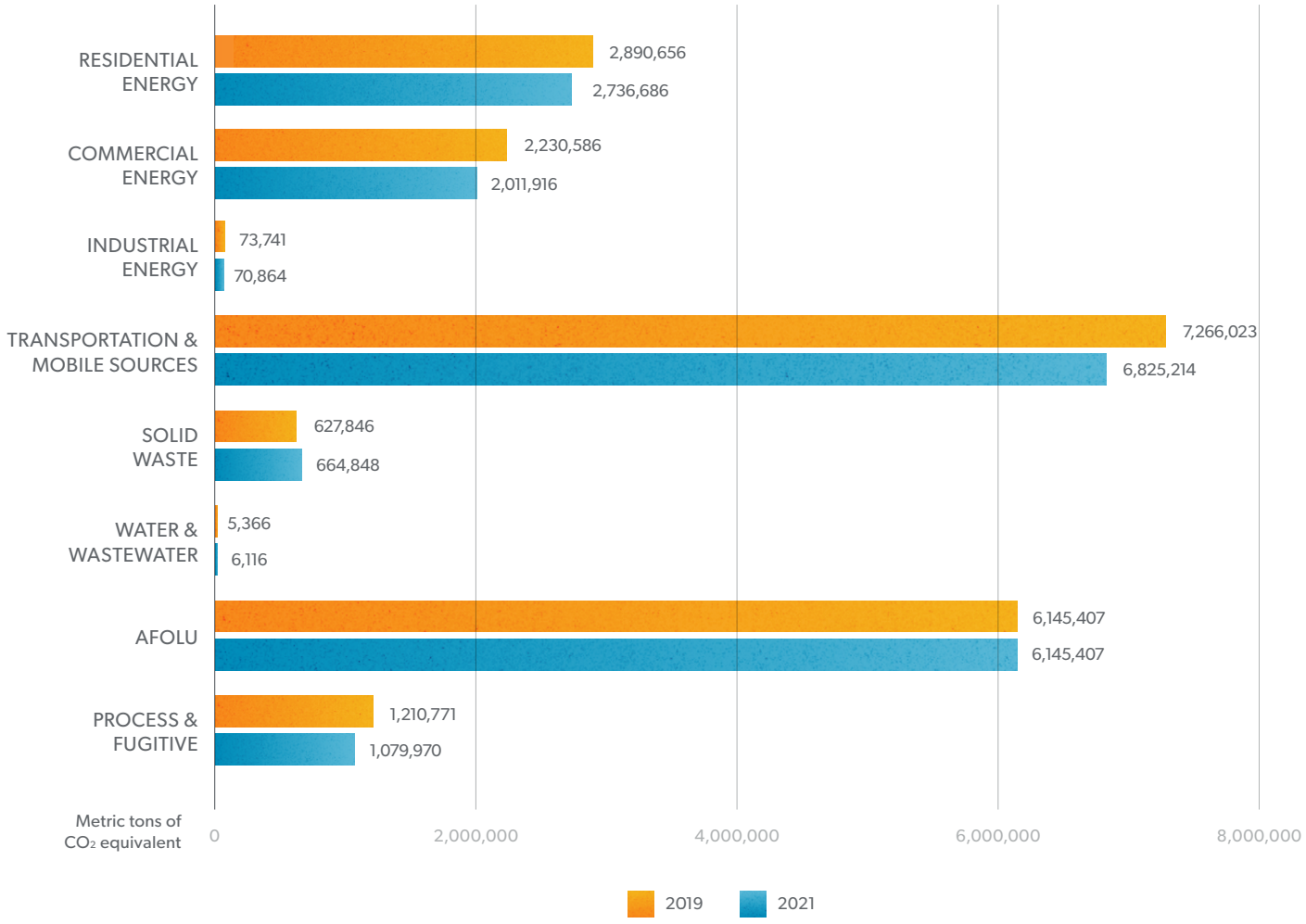


Figure 10 shows the distribution of community-wide emissions by sector. Transportation is the largest contributor, followed by agriculture and residential energy.

Table 1 lists total Compact region emissions by sector, while Table 2 further breaks down sectoral emissions by county.

SECTOR	2019 EMISSIONS ($MTCO_2e$)	2021 EMISSIONS ($MTCO_2e$)	PERCENTAGE CHANGE
Residential Energy	10,141,364	10,169,533	0.3%
Commercial Energy	10,548,811	9,790,172	-7.2%
Industrial Energy	682,988	912,756	33.6%
Transportation and Mobile Sources	37,372,223	33,046,526	-11.6%
Solid Waste	2,680,775	2,733,048	1.9%
Water and Wastewater	22,651	25,583	12.9%
Agriculture	6,068,211	6,068,211	0.0%
Forests and Trees	333,980	333,980	0.0%
Process and Fugitive	7,236,579	6,432,648	-11.1%
TOTAL GROSS EMISSIONS	**75,087,582**	**69,512,457**	**-7.4%**

TABLE 1: Regional Emissions by Sector, 2019 and 2021

SECTOR	COUNTY	2019 EMISSIONS ($MTCO_2e$)	2021 EMISSIONS ($MTCO_2e$)
RESIDENTIAL ENERGY	Broward	2,463,155	2,945,841
	Miami-Dade	4,544,614	4,259,071
	Monroe	242,939	227,935
	Palm Beach	2,890,656	2,736,686
Residential Energy Total		**10,141,364**	**10,169,533**

TABLE 2: Emissions by County and Sector, 2019 and 2021

(continue next page)

SECTOR	COUNTY	2019 EMISSIONS ($MTCO_2e$)	2021 EMISSIONS ($MTCO_2e$)
COMMERCIAL ENERGY	Broward	2,964,940	2,909,116
	Miami-Dade	5,205,852	4,738,443
	Monroe	147,433	130,697
	Palm Beach	2,230,586	2,011,916
Commercial Energy Total		**10,548,811**	**9,790,172**
INDUSTRIAL ENERGY	Broward	101,930	90,638
	Miami-Dade	457,843	705,791
	Monroe	49,474	45,463
	Palm Beach	73,741	70,864
Industrial Energy Total		**682,988**	**912,756**
TRANSPORTATION AND MOBILE SOURCES	Broward	10,774,014	9,335,919
	Miami-Dade	18,538,466	16,104,541
	Monroe	793,720	780,852
	Palm Beach	7,266,023	6,825,214
Transportation and Mobile Sources Total		**37,372,223**	**33,046,526**
SOLID WASTE	Broward	803,234	769,722
	Miami-Dade	1,195,178	1,252,110
	Monroe	54,517	46,368
	Palm Beach	627,846	664,848
Solid Waste Total		**2,680,775**	**2,733,048**

TABLE 2: Emissions by County and Sector, 2019 and 2021

(continue next page)

SECTOR	COUNTY	2019 EMISSIONS ($MTCO_2e$)	2021 EMISSIONS ($MTCO_2e$)
WATER AND WASTEWATER	Broward	7,055	7,987
	Miami-Dade	9,887	11,107
	Monroe	343	373
	Palm Beach	5,366	6,116
Water and Wastewater Total		**22,651**	**25,583**
AGRICULTURE	Broward	N/A	0
	Miami-Dade	22,208	22,208
	Monroe	N/A	0
	Palm Beach	6,046,003	6,046,003
Agriculture Total		**6,068,211**	**6,068,211**
FORESTS AND TREES	Broward	59,276	59,276
	Miami-Dade	156,720	156,720
	Monroe	18,580	18,580
	Palm Beach	99,404	99,404
Forests and Trees Total		**333,980**	**333,980**
PROCESS AND FUGITIVE	Broward	1,589,203	1,409,568
	Miami-Dade	4,373,668	3,882,950
	Monroe	62,937	60,160
	Palm Beach	1,210,771	1,079,970
Process and Fugitive Total		**7,236,579**	**6,432,648**
TOTAL GROSS EMISSIONS		**75,087,582**	**69,512,457**

TABLE 2: Emissions by County and Sector, 2019 and 2021

SECTOR PROFILES

This section describes what kinds of emission sources make up each sector and compares each county's sector emissions and per capita emissions for that sector for 2019 and 2021.

RESIDENTIAL SECTOR

The residential energy sector includes emissions from electricity and fuels used in residential buildings, specifically:

- Electricity
- Methane gas (natural gas)
- Distillate Fuel Oil No.2
- Propane

FIGURE 11: Residential Sector Emissions

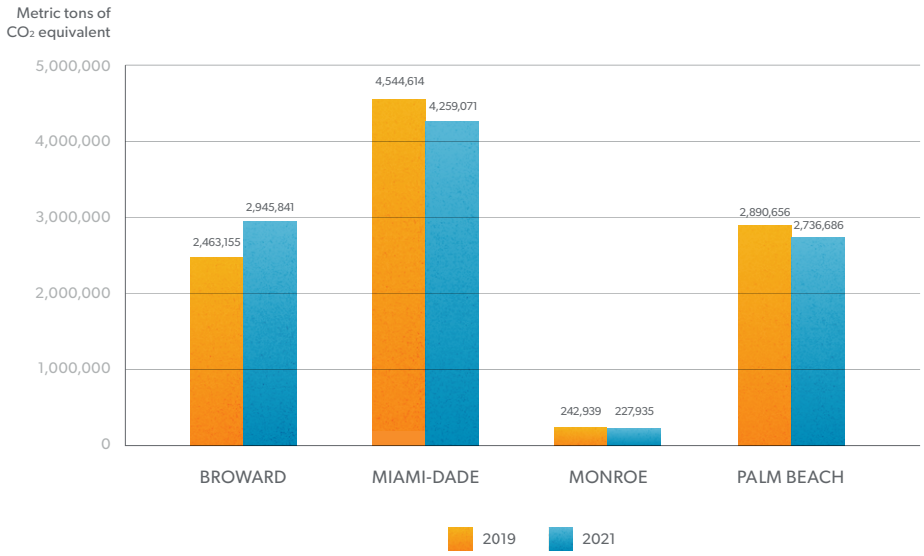
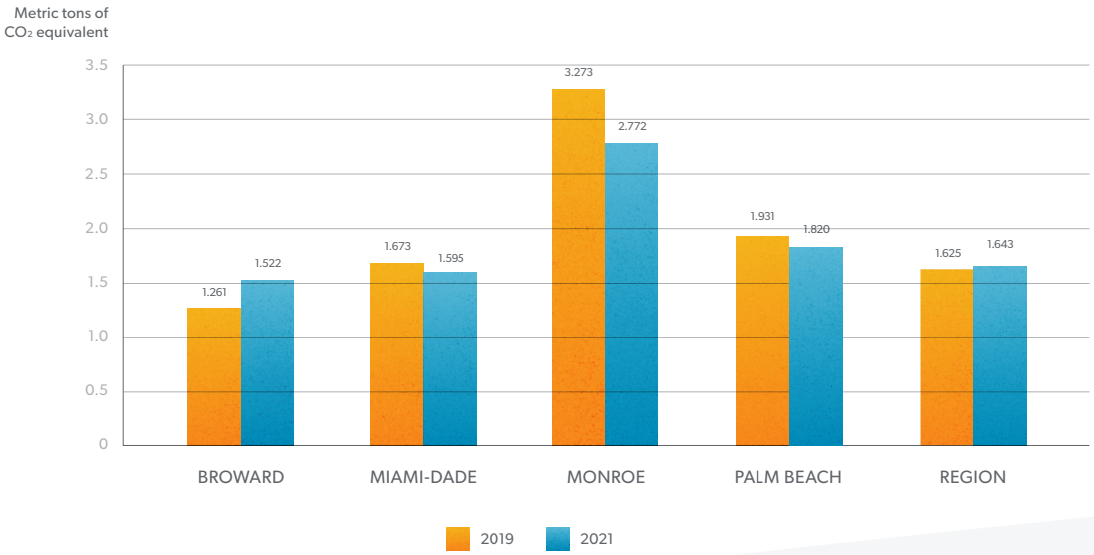


FIGURE 12: Residential Emissions Per Capita



COMMERCIAL SECTOR

The commercial energy sector includes emissions from electricity and fuels used in commercial buildings, specifically:

- Electricity
- Methane gas (natural gas)
- Distillate Fuel Oil No.2
- Propane

FIGURE 13: Commercial Sector Emissions

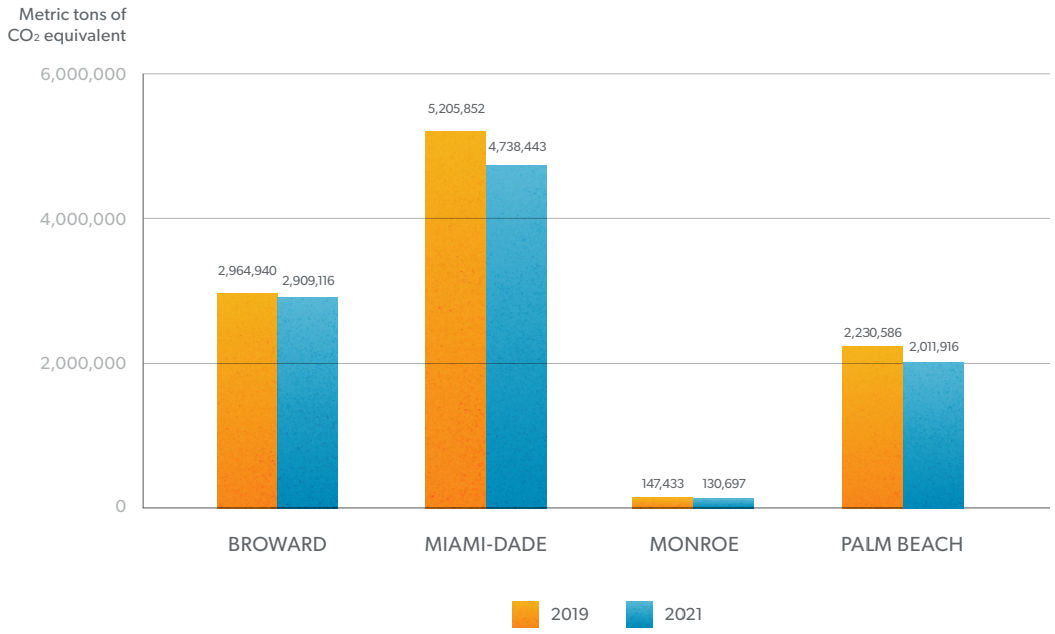
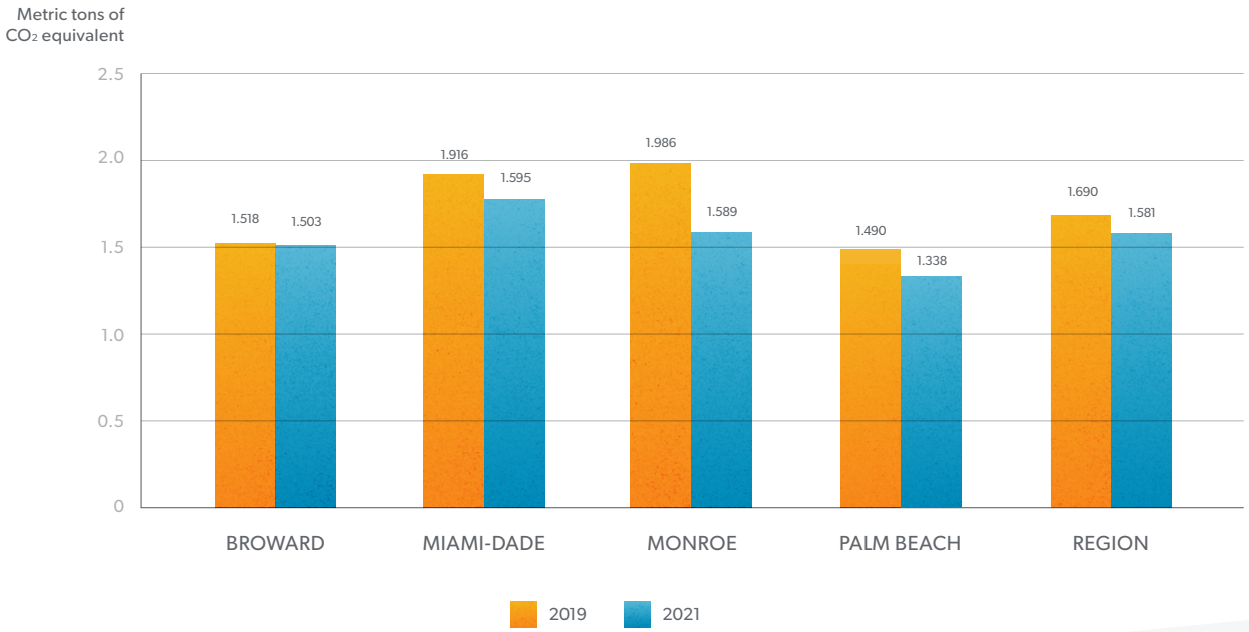


FIGURE 14: Commercial Emissions Per Capita



INDUSTRIAL SECTOR

The industrial energy sector includes emissions from electricity used in industrial buildings.

FIGURE 15: Industrial Sector Emissions

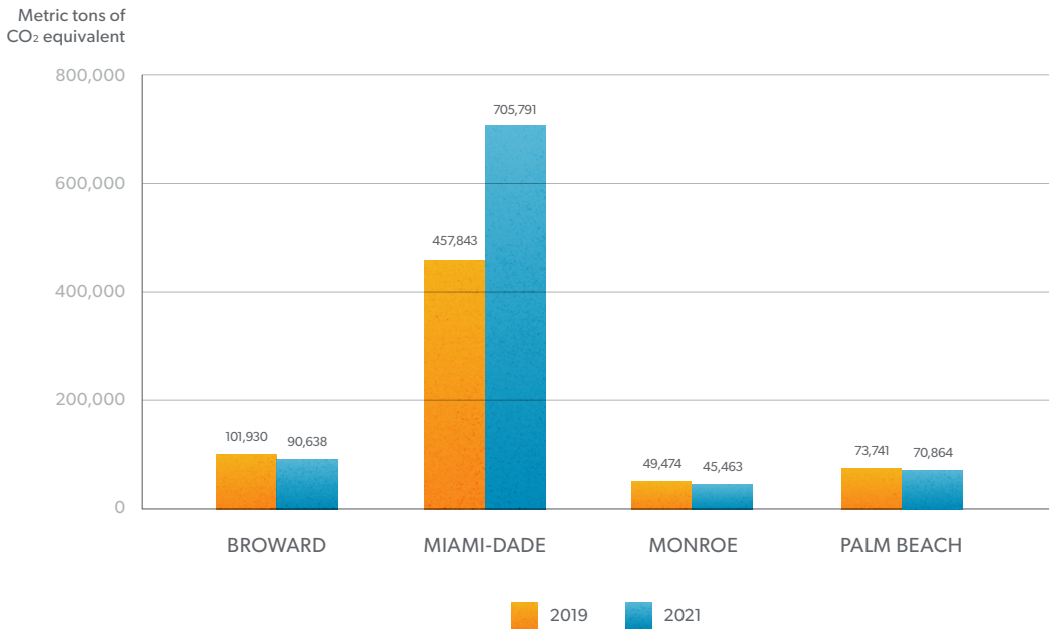
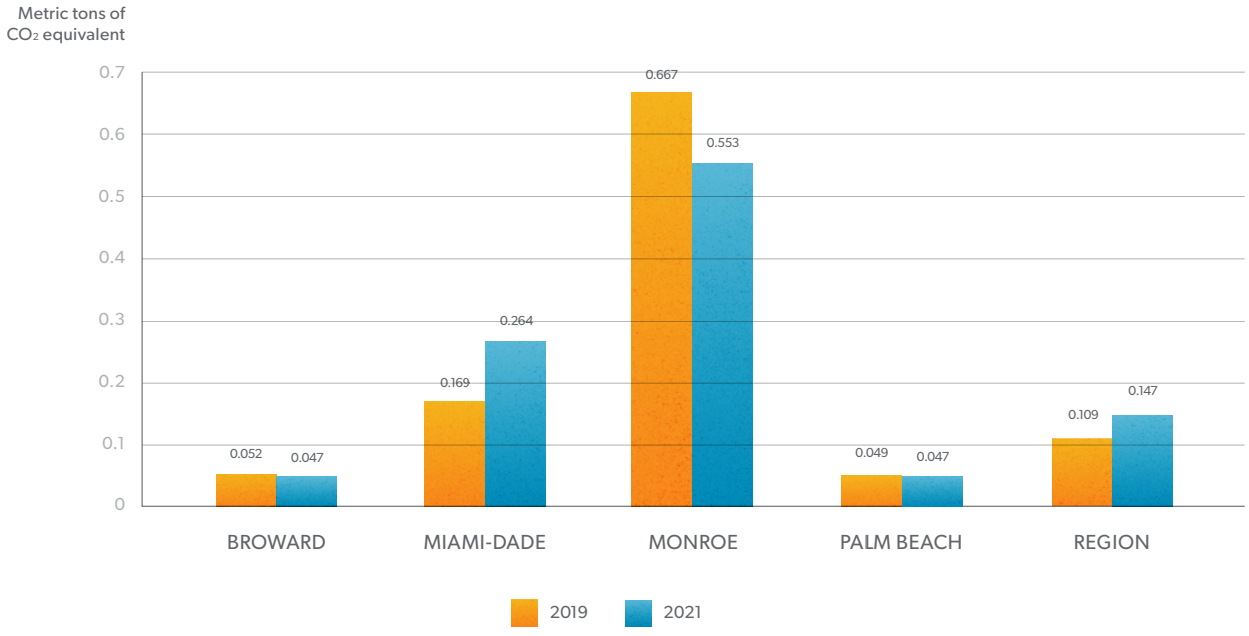


FIGURE 16: Industrial Emissions Per Capita



TRANSPORTATION AND MOBILE SOURCES SECTOR

The transportation and mobile sources sector includes emissions used by modes of transport, including:

- On-road vehicles, including passenger cars, light and heavy trucks, motorcycles, and transit buses and shuttles (Fuels: gasoline and diesel)
- Off-road vehicles used in construction, agriculture, logistics, etc., such as earth movers, digging equipment, tractors, threshers, cargo movers, and other specialized equipment (Fuels: gasoline, diesel, compressed natural gas, and liquid propane gas)
- Rail, including Brightline, Tri-Rail, Amtrak, and freight trains (Fuels: diesel, and biodiesel)
- Boats and ships. (Fuels: commercial marine oil)
- Aircraft, including jets, propeller planes, and helicopters. (Fuels: jet fuel and aviation gas)

FIGURE 17: Transportation and Mobile Sources Sector Emissions

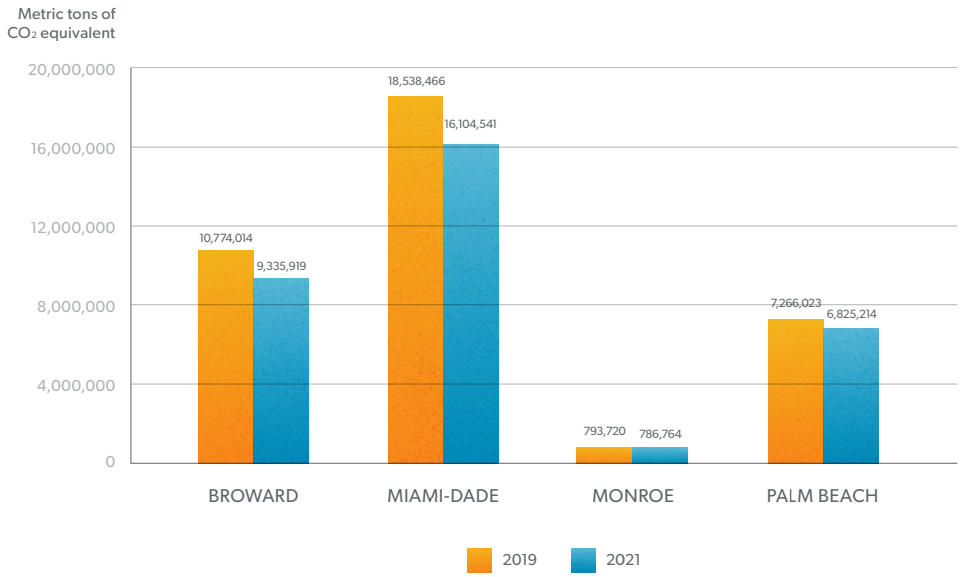
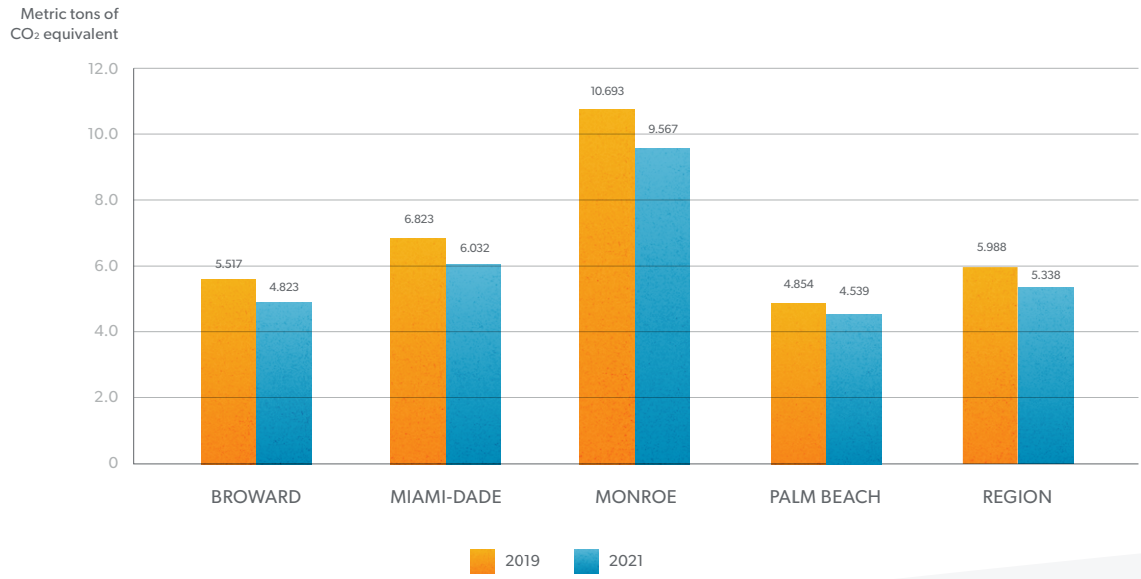


FIGURE 18: Transportation and Mobile Sources Sector Emissions Per Capita



SOLID WASTE SECTOR

This sector includes municipal solid waste landfilled and incinerated by each county.

FIGURE 19: Solid Waste Sector Emissions

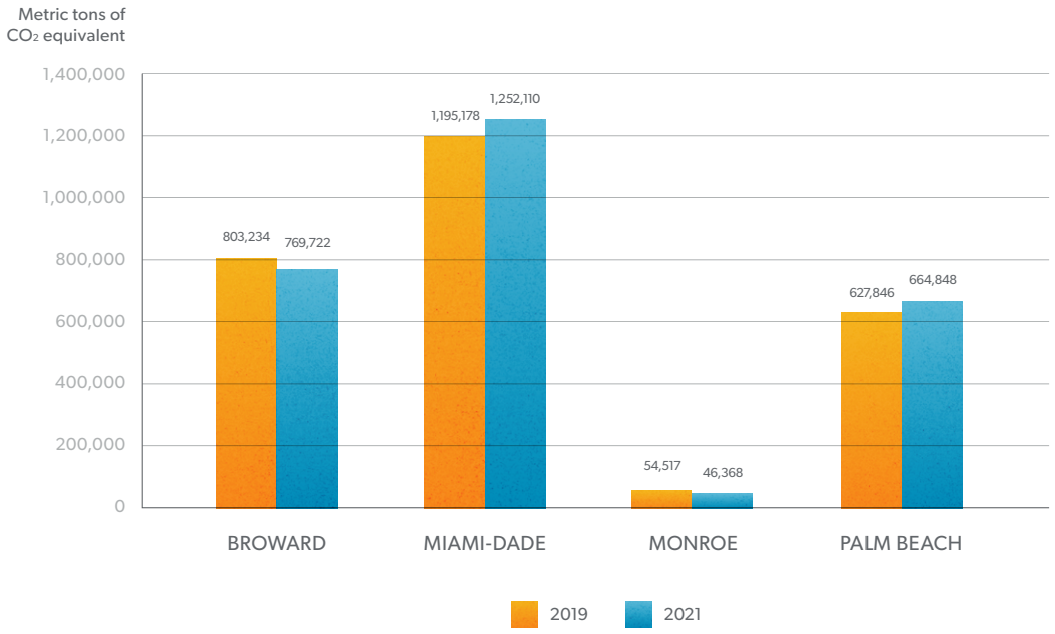
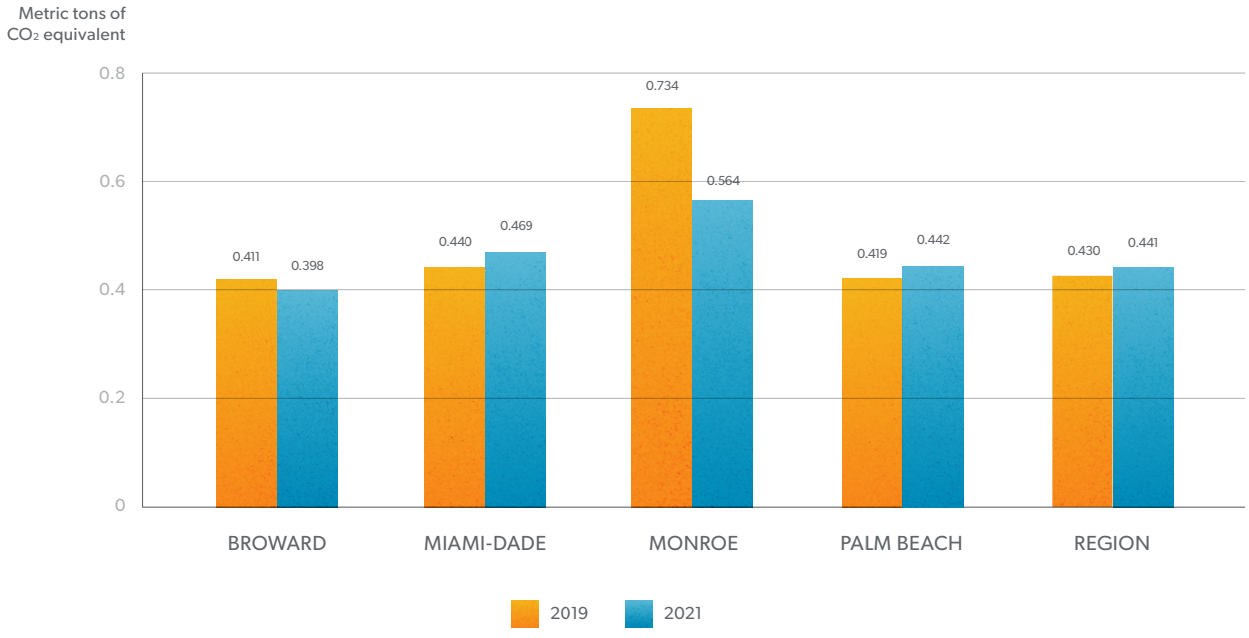


FIGURE 20: Solid Waste Sector Emissions Per Capita



WATER AND WASTEWATER SECTOR

This sector includes emissions created as a part of the wastewater treatment process, including:

- Anaerobic processes
- Nitrification and denitrification
- Flared and combusted digester gas

FIGURE 21: Water and Wastewater Sector Emissions

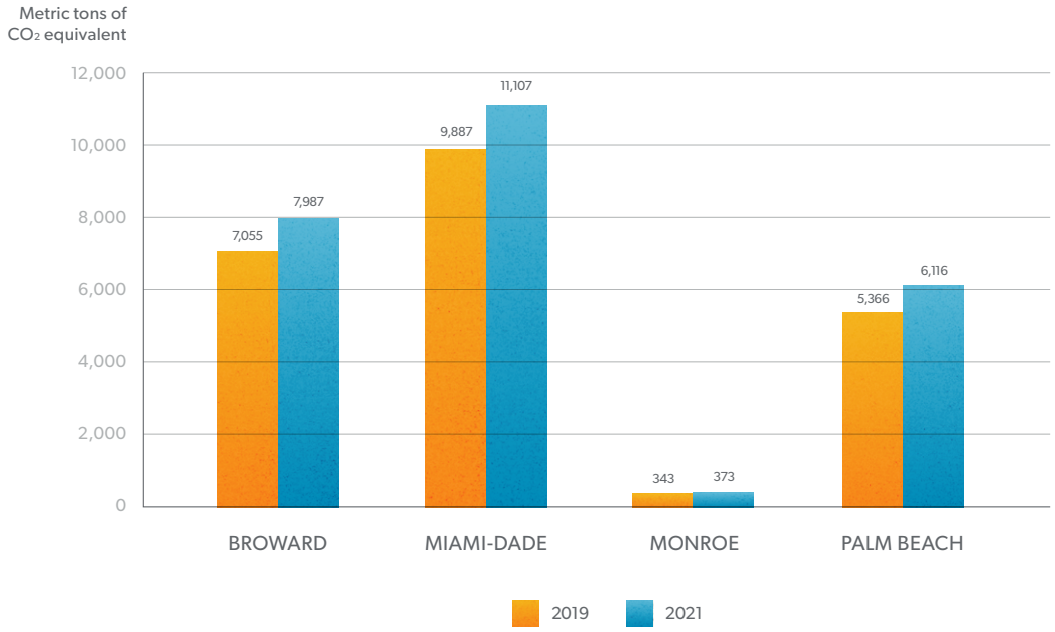
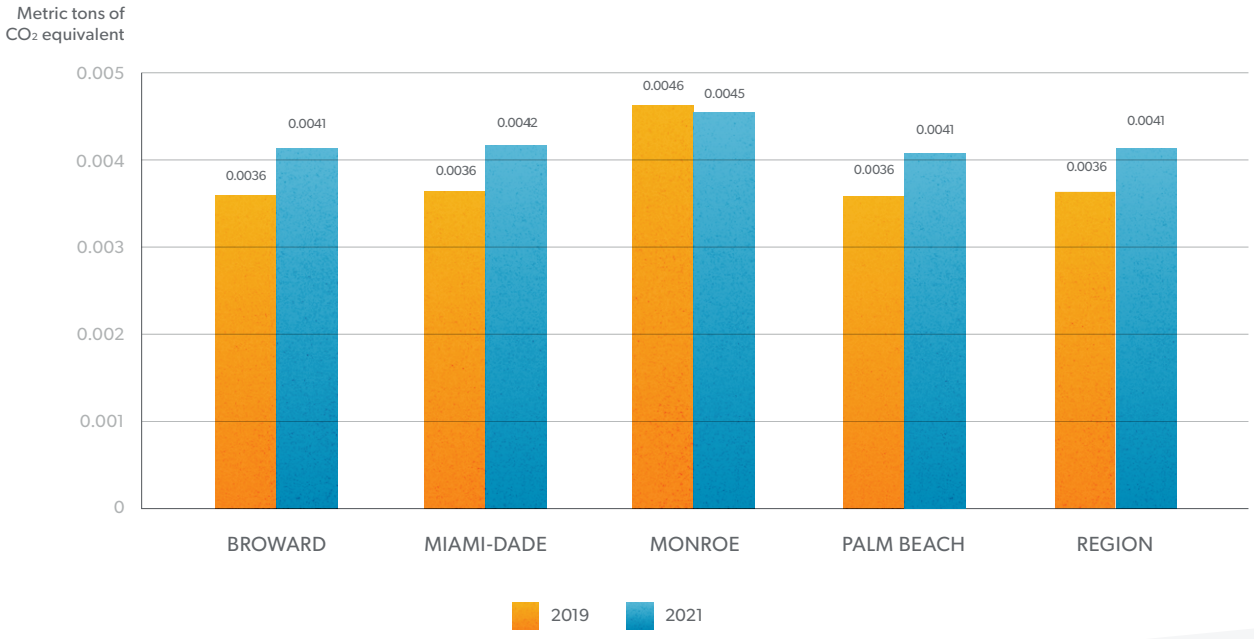


FIGURE 22: Water and Wastewater Sector Emissions Per Capita



AGRICULTURE, FORESTRY, AND OTHER LAND USE SECTOR

Agriculture, Forestry, and Other Land Use (AFOLU) Sector emissions include emissions from:

- Use of nitrogen fertilizers
- Crop cultivation, including flooded rice fields and nitrogen-fixing legumes
- Burning of spent crop fields, such as sugar cane
- Oxidation of organic soils
- Changes in land use

FIGURE 23: Agriculture, Forestry, and Other Land Use Sector Emissions

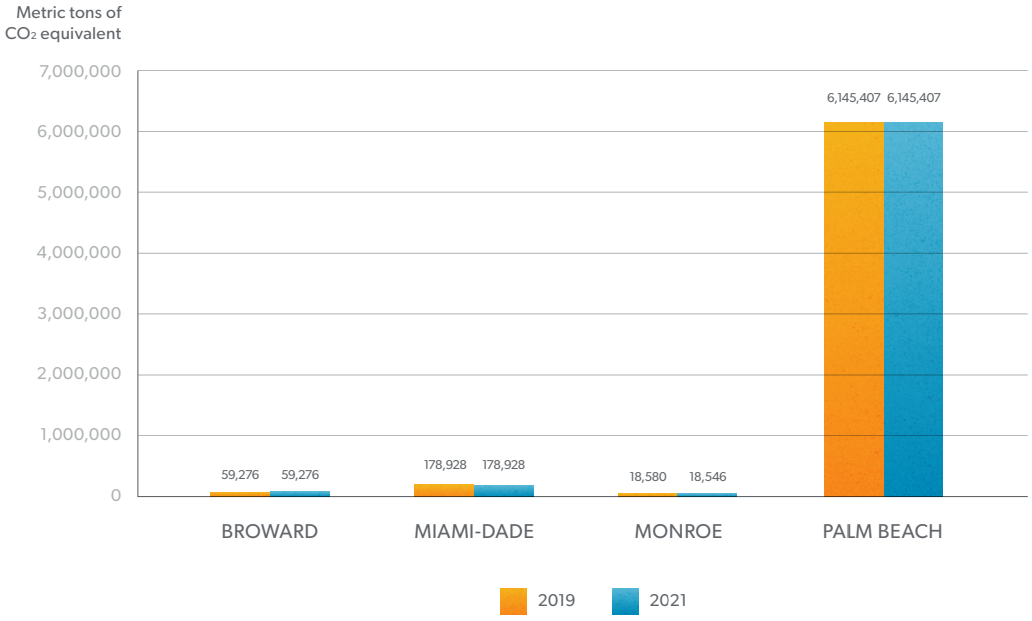
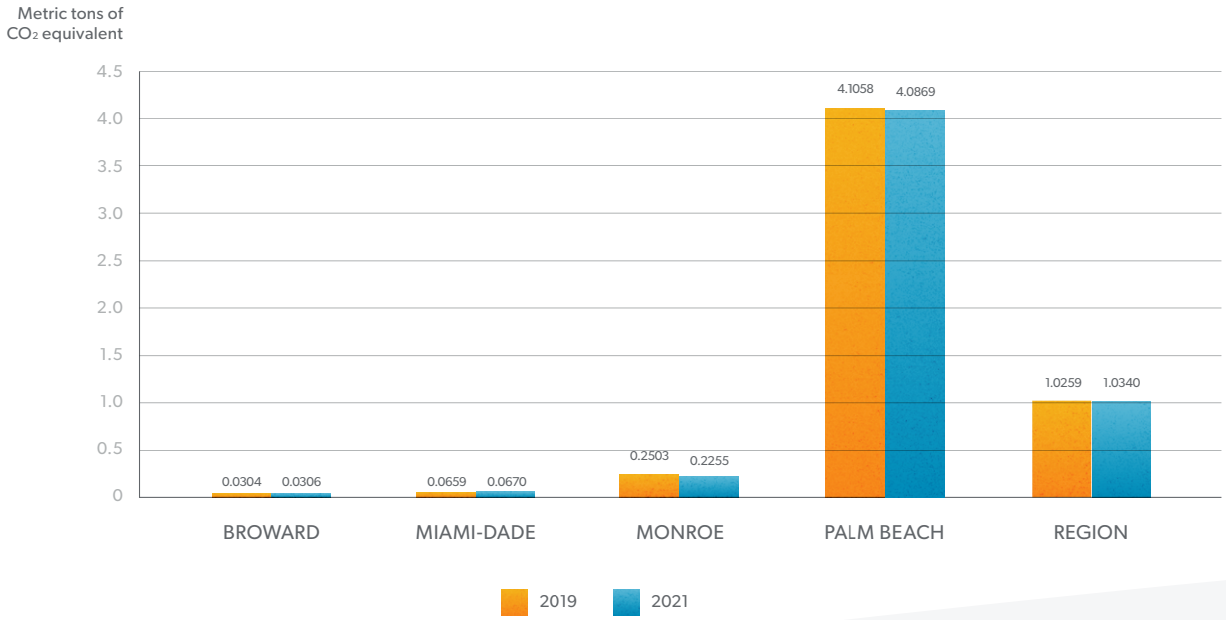


FIGURE 24: Agriculture, Forestry, and Other Land Use Sector Emissions Emissions Per Capita



PROCESS AND FUGITIVE SECTOR EMISSIONS

This sector includes emissions from industrial processes and use of chemical products not captured elsewhere, such as:

- Cement production
- Refrigerants
- Fire suppressants
- Aerosols
- Foams
- Solvents
- Sulfur hexafluoride (SF_6) used as an electrical insulator in electrical distribution transformers

FIGURE 25: Process and Fugitive Sector Emissions

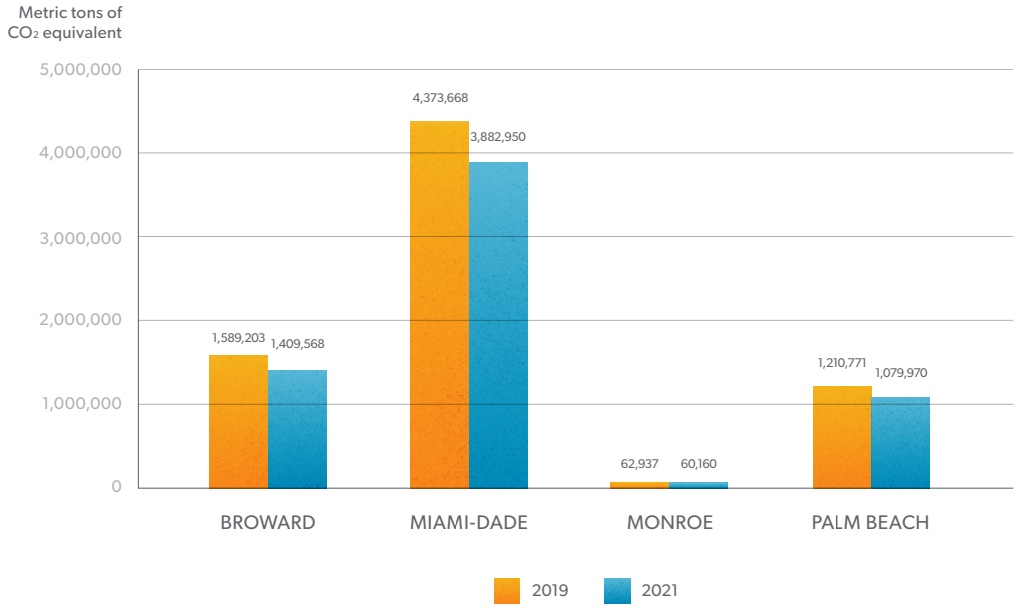
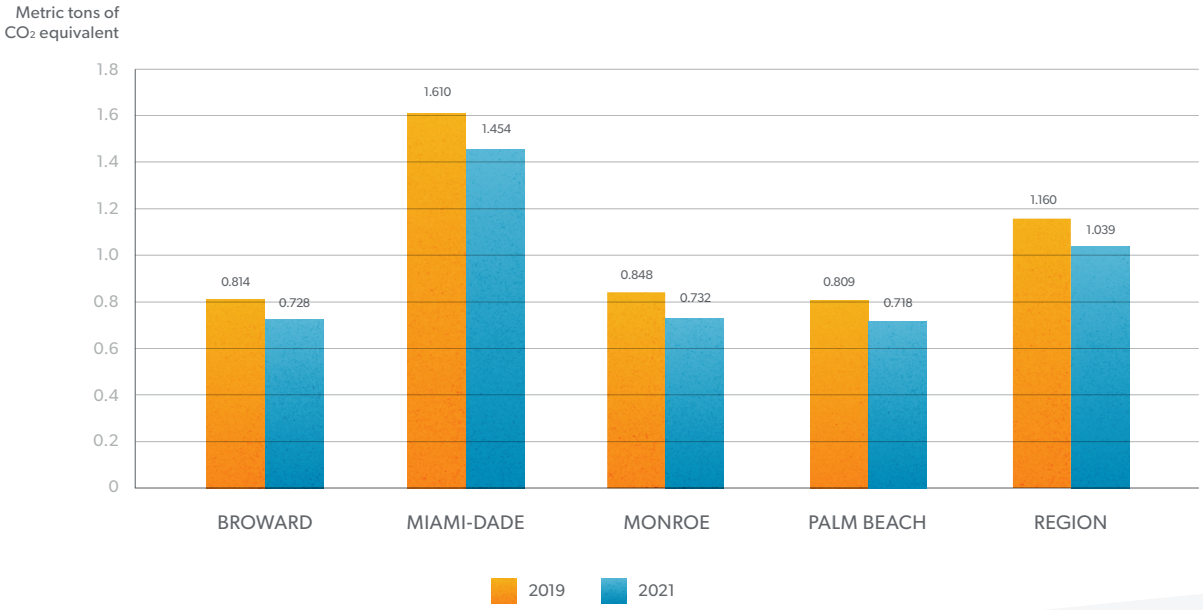


FIGURE 26: Process and Fugitive Sector Emissions Per Capita

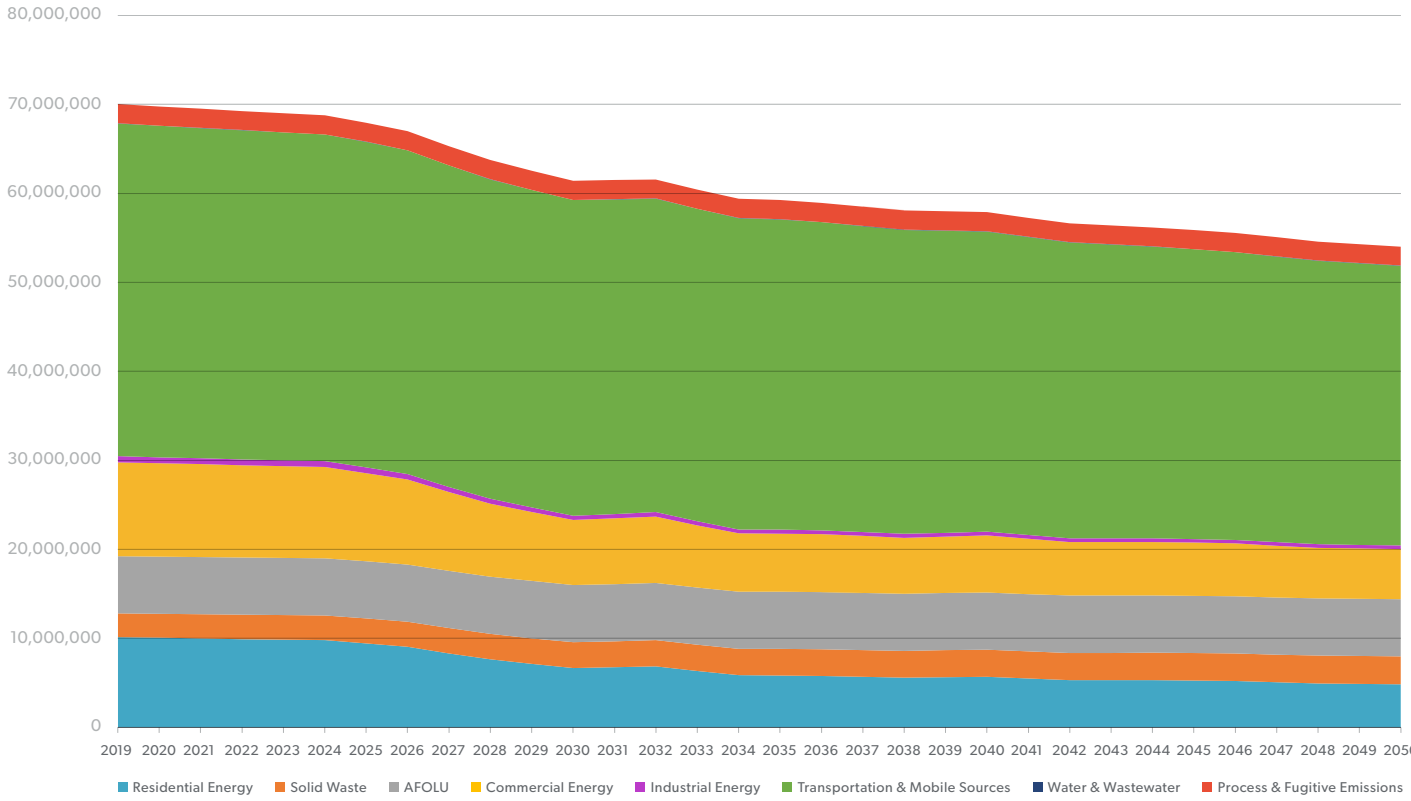


EMISSIONS PROJECTIONS

Business-as-usual emissions projections for the region are presented in Figure 27. This projection is based on the 2019 GHG inventory as a baseline. It takes into account projected federal Corporate Average Fuel Economy (CAFE) standards for vehicle efficiency; regional population growth based on the January 2024 Bureau of Economic and Business Research (BEBR) Projections of Florida Population by County, 2025–2050; and the National Renewable Energy Lab's 2023 Standard Scenario, mid-case, modeled under current policies projections for grid electricity emissions factors.

Consumption of residential and commercial power is assumed to increase with population, but industrial power consumption was held flat, as this is unlikely to scale with population growth. All transportation sectors are assumed to scale with population, and CAFE standards are applied to all types of transportation. Although these are likely to be inexact estimates for many transportation types, it is likely that all transportation types will both grow in use moving forward, and all transportation types will tend to get more efficient over time. Solid waste and wastewater emissions are assumed to simply grow with increasing population. AFOLU and process and fugitive emissions are assumed to stay flat in the absence of any other information. Under these assumptions, emissions are expected to drop from 70,015,901 $MtCO_2e$ in 2019 to 61,404,597 $MtCO_2e$ in 2030 (a 12.3% decrease) and 54,022,085 $MtCO_2e$ in 2050 (a 22.8% decrease).

FIGURE 27: Business-as-Usual GHG Emissions Projections



APPENDIX: COUNTY DETAILS

BROWARD COUNTY

SECTOR	FUEL OR SOURCE	2019 USAGE	2021 USAGE	USAGE UNIT	2019 EMISSIONS ($MTCO_2e$)	2021 EMISSIONS ($MTCO_2e$)
RESIDENTIAL ENERGY	Electricity	7,842,615	10,225,669	MWh	2,377,718	2,858,760
	Natural Gas	9,160,423	8,302,206	Therms	48,721	44,205
	Distillate Fuel Oil No.2	9,216	10,597	MMBtu	686	789
	Propane	580,581	678,181	MMBtu	36,030	42,087
Residential Energy Total					**2,463,155**	**2,954,841**
COMMERCIAL ENERGY	Electricity	8,380,360	8,763,740	MWh	2,540,751	2,450,052
	Natural Gas	59,089,843	61,912,312	Therms	314,278	329,290
	Propane	595,274	816,487	MMBtu	36,942	50,670
	Distillate Fuel Oil No.2	980,024	1,062,417	MMBtu	72,969	79,104
Commercial Energy Total					**2,964,940**	**2,909,116**
INDUSTRIAL ENERGY	Electricity	336,202	324,210	MWh	101,930	90,638
Industrial Energy Total					**101,930**	**90,638**
TRANSPORTATION AND MOBILE SOURCES	On Road Gasoline	10,847,709,855	9,633,815,218	VMT	4,529,797	3,884,021
	On-Road Diesel	1,123,475,368	1,151,028,101	VMT	1,655,286	1,657,852
	Off-Road Diesel	8,396,578	8,396,579	MMBtu	621,320	621,320
	Off-Road CNG	128,228	128,229	MMBtu	8,530	8,530

TABLE 3: Broward County - 2019 and 2021 Community-Wide Emissions Inventory (continue next page)

SECTOR	FUEL OR SOURCE	2019 USAGE	2021 USAGE	USAGE UNIT	2019 EMISSIONS ($MTCO_2e$)	2021 EMISSIONS ($MTCO_2e$)
TRANSPORTATION AND MOBILE SOURCES	Off-Road Gasoline	4,483,424	4,483,425	MMBtu	321,375	321,375
	Off-Road LPG	728,852	728,852	MMBtu	44,912	44,912
	Rail	157,703	157,703	MMBtu	11,765	11,765
	Commercial Marine	2,332,951	2,332,951	MMBtu	163,932	163,932
	Jet Fuel	348,299,178	267,022,304	Gallons	3,407,299	2,612,193
	Avgas	1,174,983	1,201,504	Gallons	9,798	10,019
Transportation and Mobile Sources Total					**10,774,014**	**9,335,919**
SOLID WASTE	Waste Sent to Landfill	2,134,756	2,337,440	Tons	608,905	584,804
	Waste Sent to Incinerator	560,655	533,504	Tons	194,329	184,918
Solid Waste Total					**803,234**	**769,722**
WATER AND WASTEWATER	Combusted digester gas				42	1,060
	Flared digester gas				163	47
	Process N_2O				4,466	4,486
	Effluent N_2O				2,384	2,394
Water and Wastewater Total					**7,055**	**7,987**
TREES AND FORESTS	Trees and Forests				16,976	16,976
	Trees Outside of Forests				42,300	42,300
Trees and Forests Total					**59,276**	**59,276**

TABLE 3: Broward County - 2019 and 2021 Community-Wide Emissions Inventory (continue next page)

SECTOR	FUEL OR SOURCE	2019 USAGE	2021 USAGE	USAGE UNIT	2019 EMISSIONS ($MTCO_2e$)	2021 EMISSIONS ($MTCO_2e$)
PROCESS AND FUGITIVE	Electric Power Systems SF_6				8,559	7,614
	Fire Extinguishing				17,817	17,754
	Refrigeration				1,312,019	1,178,094
	Non-MDI Aerosols				117,270	108,312
	Foams				103,228	68,766
	MDI Aerosols				18,648	17,010
	Solvents				11,662	12,018
Process and Fugitive Total					**1,589,203**	**1,409,568**
TOTAL GROSS EMISSIONS					**18,762,807**	**17,528,067**

TABLE 3: Broward County - 2019 and 2021 Community-Wide Emissions Inventory

*Blank cells are a result of variability in the format of available data by sector and fuel or source type.

MIAMI-DADE COUNTY

SECTOR	FUEL OR SOURCE	2019 USAGE	2021 USAGE	USAGE UNIT	2019 EMISSIONS ($MTCO_2e$)	2021 EMISSIONS ($MTCO_2e$)
RESIDENTIAL ENERGY	Electricity	14,523,149	14,719,019	MWh	4,403,117	4,114,952
	Natural Gas	16,929,371	9,795,802	Therms	90,041	90,336
	Distillate Fuel Oil No.2	12,915	13,292	MMBtu	962	990
	Propane	813,639	1,440,543	MMBtu	50,494	52,793
Residential Energy Total					**4,544,614**	**4,259,071**
COMMERCIAL ENERGY	Electricity	15,322,049	14,860,739	MWh	4,645,327	4,154,572
	Natural Gas	76,092,351	76,694,121	Therms	404,709	407,909.00
	Propane	843,895	1,107,084	MMBtu	52,371	68,704.00
	Distillate Fuel Oil No.2	1,389,339	1,440,543	MMBtu	103,445	107,258.00
Commercial Energy Total					**5,205,852**	**4,738,443**
INDUSTRIAL ENERGY	Electricity	871,263	893,821	MWh	264,149	249,883
	Natural Gas	36,494,778	85,899,606	Therms	193,694	455,908.00
Industrial Energy Total					**457,843**	**705,791**
TRANSPORTATION AND MOBILE SOURCES	On Road Gasoline	14,363,401,115	13,234,791,730	VMT	5,997,882	5,335,810
	On-Road Diesel	1,487,588,401	1,581,265,245	VMT	2,191,756	2,277,533
	Off-Road Diesel	11,196,299	11,196,299	MMBtu	828,505	828,505
	Off-Road CNG	220,351	220,351	MMBtu	14,784	14,784
	Off-Road Gasoline	5,579,400	5,579,400	MMBtu	399,854	399,854

TABLE 4: Miami-Dade County - 2019 and 2021 Community-Wide Emissions Inventory (continue next page)

SECTOR	FUEL OR SOURCE	2019 USAGE	2021 USAGE	USAGE UNIT	2019 EMISSIONS ($MTCO_2e$)	2021 EMISSIONS ($MTCO_2e$)
TRANSPORTATION AND MOBILE SOURCES	Off-Road LPG	1,076,998	1,076,998	MMBtu	66,377	66,377
	Rail	109,271	109,271	MMBtu	8,152	8,152
	Commercial Marine	4,702,587	4,702,587	MMBtu	330,441	330,441
	Jet Fuel	889,399,912	699,510,234	Gallons	8,700,715	6,843,085
Transportation and Mobile Sources Total					**18,538,466**	**16,104,541**
SOLID WASTE	Waste Sent to Landfill	3,048,221	3,071,292	Tons	1,028,247	1,062,212
	Waste Sent to Incinerator	481,611	547,872	Tons	166,931	189,898
Solid Waste Total					**1,195,178**	**1,252,110**
WATER AND WASTEWATER	Combusted digester gas				59	66
	Flared digester gas				228	1,474
	Process N_2O				6,259	6,238
	Effluent N_2O				3,341	3,329
Water and Wastewater Total					**9,887**	**11,107**
AGRICULTURE	Nitrogen Fertilizer	55,206	55,206	Acres	20,935	20,935
	Legume Nitrification	7,555	7,555	Acres	1,273	1,273
Agriculture Total					**22,208**	**22,208**

TABLE 4: Miami-Dade County - 2019 and 2021 Community-Wide Emissions Inventory (continue next page)

SECTOR	FUEL OR SOURCE	2019 USAGE	2021 USAGE	USAGE UNIT	2019 EMISSIONS ($MTCO_2e$)	2021 EMISSIONS ($MTCO_2e$)
TREES AND FORESTS	Trees and Forests				94,015	94,015
	Trees Outside of Forests				62,705	62,705
Trees and Forests Total					**156,720**	**156,720**
PROCESS AND FUGITIVE	Electric Power Systems SF_6				15,877	12,014
	Fire Extinguishing				24,970	24,688
	Refrigeration				1,838,693	1,638,213
	Non-MDI Aerosols				164,345	150,614
	Foams				144,667	95,623
	MDI Aerosols				26,134	23,654
	Solvents				16,343	16,712
	Cemex Miami Process and Stationary Combustion				709,545	684,728
	Tarmac Pennsuco Complex Process and Stationary Combustion				1,433,094	1,236,704
Process and Fugitive Total					**4,373,668**	**3,882,950**
TOTAL GROSS EMISSIONS					**34,504,436**	**31,132,941**

TABLE 4: Miami-Dade County - 2019 and 2021 Community-Wide Emissions Inventory

*Blank cells are a result of variability in the format of available data by sector and fuel or source type.

MONROE COUNTY

SECTOR	FUEL OR SOURCE	2019 USAGE	2021 USAGE	USAGE UNIT	2019 EMISSIONS ($MTCO_2e$)	2021 EMISSIONS ($MTCO_2e$)
RESIDENTIAL ENERGY	Electricity	796,537	805,660	MWh	241,494	225,236
	Distillate Fuel Oil No.2	363	667	MMBtu	27	50
	Propane	22,846	42,689	MMBtu	1,418	2,649
Residential Energy Total					**242,938**	**227,935**
COMMERCIAL ENERGY	Electricity	465,224	102,563	MWh	141,046	124,926
	Propane	34,592	36,311	MMBtu	2,147	2,253
	Distillate Fuel Oil No.2	56,950	47,248	MMBtu	4,240	3,518
Commercial Energy Total					**147,433**	**130,697**
INDUSTRIAL ENERGY	Electricity	163,185	162,619	MWh	49,474	45,463
Industrial Energy Total					**49,474**	**45,463**
TRANSPORTATION AND MOBILE SOURCES	On Road Gasoline	764,995,737	724,243,286	VMT	319,448	291,990
	On-Road Diesel	79,229,061	86,531,074	VMT	116,733	124,633
	Off-Road Diesel	1,255,808	1,255,808	MMBtu	92,956	92,956
	Off-Road CNG	2,894	2,894	MMBtu	197	197
	Off-Road Gasoline	3,088,739	3,088,739	MMBtu	222,207	222,207
	Off-Road LPG	11,604	11,604	MMBtu	716	716
	Commercial Marine	439,600	439,600	MMBtu	30,890	30,890
	Jet Fuel	959,512	1,645,781	Gallons	9,387	16,100
	Avgas	142,178	139,510	Gallons	1,186	1,163

TABLE 5: Monroe County - 2019 and 2021 Community-Wide Emissions Inventory (continue next page)

SECTOR	FUEL OR SOURCE	2019 USAGE	2021 USAGE	USAGE UNIT	2019 EMISSIONS ($MTCO_2e$)	2021 EMISSIONS ($MTCO_2e$)
Transportation and Mobile Sources Total					**793,720**	**780,852**
SOLID WASTE	Waste Sent to Landfill	116,364	130,303	Tons	28,226	33,765
	Waste Sent to Incinerator	75,853	36,360	Tons	26,291	12,603
Solid Waste Total					**54,517**	**46,368**
WATER AND WASTEWATER	Flared Digester Gas				80	87
	Effluent N_2O				263	286
Water and Wastewater Total					**343**	**373**
FOREST AND TREES	Forests and Trees				18,580	18,546
Forest and Trees Total					**18,580**	**18,546**
PROCESS AND FUGITIVE	Electric Power Systems SF_6				737	558
	Fire Extinguishing				701	755
	Refrigeration				51,629	50,085
	Non-MDI Aerosols				4,615	4,605
	Foams				4,062	2,923
	MDI Aerosols				734	723
	Solvents				459	511
Process and Fugitive Total					**62,937**	**60,160**
TOTAL GROSS EMISSIONS					**1,369,943**	**1,309,160**

TABLE 5: Monroe County - 2019 and 2021 Community-Wide Emissions Inventory

*Blank cells are a result of variability in the format of available data by sector and fuel or source type.

PALM BEACH COUNTY

SECTOR	FUEL OR SOURCE	2019 USAGE	2021 USAGE	USAGE UNIT	2019 EMISSIONS ($MTCO_2e$)	2021 EMISSIONS ($MTCO_2e$)
RESIDENTIAL ENERGY	Electricity	9,363,201	9,563,230	MWh	2,838,728	2,673,564
	Natural Gas	4,512,799	5,211,836	Therms	24,002	27,720
	Propane	441,576	559,971	MMBtu	27,404	34,751
	Distillate Fuel Oil No.2	7,009	8,750	MMBtu	522	651
Residential Energy Total					**2,890,656**	**2,736,686**
COMMERCIAL ENERGY	Electricity	6,974,332	6,753,715	MWh	2,114,473	1,888,116
	Natural Gas	6,374,818	6,005,579	Therms	33,905	31,942
	Propane	445,235	577,932	MMBtu	27,631	35,866
	Distillate Fuel Oil No.2	733,009	752,008	MMBtu	54,577	55,992
Commercial Energy Total					**2,230,586**	**2,001,916**
INDUSTRIAL ENERGY	Electricity	243,225	253,476	MWh	73,741	70,864
Industrial Energy Total					**73,741**	**70,864**
TRANSPORTATION AND MOBILE SOURCES	On Road Gasoline	9,825,802,489	9,078,064,752	VMT	4,103,068	3,659,962
	On-Road Diesel	1,017,638,489	1,084,628,197	VMT	1,499,350	1,562,215
	Off-Road Diesel	7,237,476	7,237,476	MMBtu	535,560	535,560
	Off-Road CNG	67,064	67,064	MMBtu	4,442	4,442
	Off-Road Gasoline	5,381,407	5,381,407	MMBtu	386,349	386,349
	Off-Road LPG	397,570	397,570	MMBtu	24,498	24,498

TABLE 6: Palm Beach County - 2019 and 2021 Community-Wide Emissions Inventory (continue next page)

SECTOR	FUEL OR SOURCE	2019 USAGE	2021 USAGE	USAGE UNIT	2019 EMISSIONS ($MTCO_2e$)	2021 EMISSIONS ($MTCO_2e$)
TRANSPORTATION AND MOBILE SOURCES	Rail	260,658	260,658	MMBtu	19,444	19,444
	Commercial Marine	949,442	949,442	MMBtu	66,715	66,715
	Jet Fuel	63,932,886	57,753,987	Gallons	625,435	564,989
	Avgas	139,311	124,764	Gallons	1,162	1,040
Transportation and Mobile Sources Total					**7,266,023**	**6,825,214**
SOLID WASTE	Waste Sent to Landfill	1,218,865	695,719	Tons	486,214	293,314
	Waste Sent to Incinerator	408,620	1,071,908	Tons	141,632	371,534
Solid Waste Total					**627,846**	**664,848**
WATER AND WASTEWATER	Combusted digester gas				32	36
	Flared digester gas				124	812
	Process N_2O				3,397	3,435
	Effluent N_2O				1,813	1,833
Water and Wastewater Total					**5,366**	**6,116**
AGRICULTURE	Soil Oxidation	420,000		Acres	5,945,000	5,945,000
	Methane from Rice	25,000		Acres	15,200	15,200
	Field Burning	280,000		Acres	84,681	84,681
	Legume Nitrification	6,667		Acres	1,122	1,122
Agriculture Total					**6,046,003**	**6,046,003**

TABLE 6: Palm Beach County - 2019 and 2021 Community-Wide Emissions Inventory (continue next page)

SECTOR	FUEL OR SOURCE	2019 USAGE	2021 USAGE	USAGE UNIT	2019 EMISSIONS ($MTCO_2e$)	2021 EMISSIONS ($MTCO_2e$)
FORESTS AND TREES	Trees and Forests				46,152	46,152
	Trees Outside of Forests				53,252	53,252
Forests and Trees Total					**99,404**	**99,404**
PROCESS AND FUGITIVE	Electric Power Systems SF_6				8,570	6,533
	Fire Extinguishing				13,551	13,593
	Refrigeration				997,891	902,035
	Non-MDI Aerosols				89,193	82,931
	Foams				78,513	52,652
	MDI Aerosols				14,183	13,024
	Solvents				8,870	9,202
Process and Fugitive Total					**1,210,771**	**1,079,970**
TOTAL GROSS EMISSIONS					**20,450,396**	**19,541,021**

TABLE 6: Palm Beach County - 2019 and 2021 Community-Wide Emissions Inventory

*Blank cells are a result of variability in the format of available data by sector and fuel or source type.

APPENDIX: DETAILED METHODOLOGY

ACTIVITY-BASED INVENTORYING

This inventory uses activity-based inventorying to estimate emissions. For each source, an activity is quantified. Examples of emitting activities include driving a diesel-powered vehicle a certain number of miles, landfilling a certain mass of municipal solid waste, or consuming a certain amount of electricity. Each activity is then multiplied by an emissions factor that quantifies the amount of CO_2, CH_4, or N_2O associated with each unit of that activity. Examples of emissions factors include the mass of CO_2 emitted when driving a diesel-powered vehicle one mile, the mass of CH_4 emitted by anaerobic decomposition of one ton of municipal solid waste in a landfill, or the mass of N_2O emitted by the burning of fuel to produce one kWh of electricity.

GLOBAL WARMING POTENTIAL

This inventory uses the Intergovernmental Panel on Climate Change (IPCC) 5th Assessment, 100-year values for global warming potentials (GWP) to calculate GHG emissions. The GWP allows the comparison of how much heat different greenhouse gases trap in the atmosphere relative to carbon dioxide and allows their heating potential to be expressed in CO_2-equivalents (CO_2e). Specifically, it is a measure of how much energy the emissions of one ton of a gas will absorb over a given period of time relative to the emissions of one ton of carbon dioxide (CO_2), and takes into account various factors such as how absorbent the gas is and how long it remains in the atmosphere. The larger the GWP, the more that a given gas warms the Earth compared to CO_2 over a certain time period. As atmospheric and climate science findings evolve, the GWP of each gas is updated to better reflect the global warming impact of emissions.

GHG NAME	CHEMICAL FORMULA	GLOBAL WARMING POTENTIAL
Carbon dioxide	CO_2	1
Methane	CH_2	28
Nitrous Oxide	N_2O	265

TABLE 7: Global Warming Potential Values (Relative to CO_2, 100-Year Time Horizon) from the IPCC Fifth Assessment

INVENTORY PLATFORM

ICLEI's ClearPath community-scale inventory platform was used to conduct calculations of GHG emissions. ClearPath is a cloud-based application for energy and emission management created and supported by ICLEI, and the most widely-used software tool for managing local government climate mitigation efforts in the United States.

DATA SOURCES

Table 8 presents the sources for the quantities of emission sources and components included in the GHG inventory. When no information is provided in the "Data/Information Provided" column, the needed information was calculated directly by the tool named in the "Data Sources" column.

EMISSION SOURCE OR COMPONENT	DATA/INFORMATION PROVIDED	DATA SOURCES	DATA GAPS
RESIDENTIAL, COMMERCIAL, AND INDUSTRIAL ENERGY			
Electricity	Consumption in MWh	» Florida Power and Light (Broward, Miami-Dade, and Palm Beach Counties) » Homestead Public Services (Miami-Dade County) » Keys Energy Services (Monroe County) » Florida Keys Electric Cooperative (Monroe County)	» Lake Worth Beach Utilities (Palm Beach County) did not provide data
Natural Gas	Consumption in therms	» TECO Peoples Gas » Sunrise Regional Utilities (Broward County) » Florida City Gas (Miami-Dade County)	» Florida Public Utilities provides natural gas to customers in Broward and Palm Beach Counties, but did not provide data » Sunrise Natural Gas assumes that total usage in Broward County represents 43% residential and 57% commercial » Industrial use was only available for Miami-Dade County

TABLE 8: Data Sources

(continue next page)

EMISSION SOURCE OR COMPONENT	DATA/INFORMATION PROVIDED	DATA SOURCES	DATA GAPS
Propane	Consumption in MMBtu	» U.S. Energy Information Administration (EIA), U.S. Census Bureau American Community Survey	» Scaled from state-level EIA data by population
Distillate Fuel Oil No.2	Consumption in MMBtu	» U.S. Energy Information Administration (EIA), U.S. Census Bureau American Community Survey	» Scaled from state-level EIA data by population
TRANSPORTATION			
On-Road Gasoline and Diesel	Vehicle miles traveled	» Google Environmental Insights Explorer	
On-Road Gasoline and Diesel	Passenger vehicle fuel efficiency	» Bureau of Transportation Statistics (2019) » Federal Highway Administration Highway Statistics Series (2021)	
On-Road Gasoline and Diesel	Light-duty fuel efficiency	» Bureau of Transportation Statistics (2019) » Federal Highway Administration Highway Statistics Series (2021)	
On-Road Gasoline and Diesel	Heavy-duty truck fuel efficiency	» Energy Information Agency (2019) » Federal Highway Administration Highway Statistics Series (2021)	» EIA report containing 2019 data has been deleted
Off-Road Diesel	Consumption in MMBtu	» EPA National Emissions Inventory (NEI)	» 2020 data
Off-Road CNG	Consumption in MMBtu	» EPA National Emissions Inventory (NEI)	» 2020 data

TABLE 8: Data Sources

(continue next page)

EMISSION SOURCE OR COMPONENT	DATA/INFORMATION PROVIDED	DATA SOURCES	DATA GAPS
Off-Road Gasoline	Consumption in MMBtu	» EPA National Emissions Inventory (NEI)	» 2020 data
Off-Road LPG	Consumption in MMBtu	» EPA National Emissions Inventory (NEI)	» 2020 data
Rail	Consumption in MMBtu	» EPA National Emissions Inventory (NEI)	» 2020 data » Sum of Freight (Line Haul Locomotives: Class I + Class II/III Operations) and Passenger (Line Haul Locomotives: Commuter Lines + Passenger Trains (Amtrak)), rows 104 and 105 of tab COUNTY NEI Directions (rail)
Commercial Marine	Consumption in MMBtu	» EPA National Emissions Inventory (NEI)	
Aviation Gas	Consumption in gallons	» Boca Raton (Palm Beach County) » Fort Lauderdale Executive (Broward County) » Pompano Beach (Broward County) » Key West International (Monroe County)	» Does not include smaller airfields in the region. » No data for Miami Executive, Miami Opa-Locka Executive, Miami International, Fort Lauderdale - Hollywood International, Palm Beach International
Jet Fuel	Consumption in gallons	» Miami International » Fort Lauderdale–Hollywood International » Palm Beach International » Boca Raton » Fort Lauderdale Executive » Key West International » Pompano Beach	» Does not include smaller airfields in the region » No data available for Miami Executive, Miami Opa-Locka Executive

TABLE 8: Data Sources

(continue next page)

EMISSION SOURCE OR COMPONENT	DATA/INFORMATION PROVIDED	DATA SOURCES	DATA GAPS
SOLID WASTE			
Waste Sent to Landfill	Disposals in tons	» Florida DEP County Reports County Overview Report 2019 and 2020	
Waste Sent to Incinerator	Disposals in tons		
WASTEWATER			
Combusted Digester Gas	Calculated from Census and utility data	» U.S. Census, individual responses from water utilities	Assumptions: » The entire region except Monroe County uses anaerobic processes and nitrification and denitrification » 34% of wastewater effluent is delivered to the ocean (based on Miami-Dade County data) » Per-capita amounts of flared and combusted digester gas match those of Miami-Dade County
Flared Digester Gas			
Process N_2O			
Effluent N_2O			
AGRICULTURE			
Crop Agriculture Area	Acres	» USDA Quickstats	
Crop Yield	Acres	» USDA Quickstats	
Soil Oxidation	Acres of rice and non-rice grown in muck soil	» UF/IFAS	
Methane from Rice	Acres of rice cultivated	» UF/IFAS	
Nitrogen from legumes	Acres of legumes cultivated	» UF/IFAS	
Field Burning	Annual area burned	» U.S. Forest Service	
Nitrogen fertilization	Fertilizer quantity applied to mineral soil	» UF/IFAS	Assumes a "reasonable" rate

TABLE 8: Data Sources

(continue next page)

EMISSION SOURCE OR COMPONENT	DATA/INFORMATION PROVIDED	DATA SOURCES	DATA GAPS
FORESTS AND TREES			
Trees and Forests		» ICLEI LEARN tool	
Trees Outside of Forests		» ICLEI LEARN tool	
PROCESS AND FUGITIVE			
Process and Stationary Combustion		» EPA FLIGHT system	» Does not include small sources of emissions. » Some emissions may be double counted with industrial emissions.
Electric Power Systems (SF_6)		» EPA Greenhouse Gas Inventory Data Explorer	» Emissions are allocated from state-level data » SF_6 emissions allocated based on electricity usage » All other gases in this category are allocated based on population
Fire Extinguishing			
Refrigeration			
Non-MDI Aerosols			
Foams			
MDI Aerosols			
Solvents			

TABLE 8: Data Sources

SECTOR DETAILS

RESIDENTIAL, COMMERCIAL, AND INDUSTRIAL ENERGY

Residential, commercial, and industrial energy usage comprise use of utility-supplied grid electricity, utility-supplied natural gas, and use of non-utility fuels, such as propane, by buildings in the community.

ELECTRICITY

- Florida Power and Light (FPL) provided electricity usage data for Broward, Miami-Dade, and Palm Beach Counties, separated into residential, commercial, and industrial sectors. FPL does not service Monroe County.
- Homestead Public Services Energy usage data was provided by Miami-Dade County, but the original source documentation for the data is unknown.
- KEYS Energy Services provided data for Monroe County. Data listed as "Residential" or "Senior Citizen" were combined and used for the residential sector. All other data was combined and used for the commercial sector.
- Florida Keys Electric Cooperative supplied data for Monroe County, separated into residential, commercial, and industrial sectors.
- Lake Worth Utilities, which supplies electricity to customers in Palm Beach County, did not supply data.
- CO_2 emission factors for electricity were taken from NextEra Energy reporting on FPL emissions and used for all electricity in the region. Other emission factors were taken from the EPA's eGRID system. Data from the FRCC eGRID subgrid was used.

NATURAL GAS

- No utility provides natural gas to Monroe County.
- TECO Peoples Gas supplied residential and commercial usage data for Broward, Miami-Dade, and Palm Beach Counties.
- The City of Sunrise, FL Gas System provided total natural gas usage for Broward County. The utility recommended assigning 43% of the usage to residential customers and 57% to commercial customers based on prior data. This recommendation was followed.
- Florida City Gas provided residential, commercial, and industrial usage data for Miami-Dade County.
- Florida Public Utilities provides natural gas to customers in Broward and Palm Beach Counties, but did not provide data.
- Emissions factors come from the EPA's Emission Factors Hub.

NON-UTILITY STATIONARY FUEL

- Estimates of total statewide propane and distillate fuel oil use for residential and commercial buildings were taken from the U.S. Energy Information Administration (EIA) reports:
  - *Residential Sector Energy Consumption, Florida*
  - *Commercial Sector Energy Consumption, Florida*
- Residential usage data was divided by the population of Florida for each inventory year (from the U.S. Census 5-year American Community Survey results, table DP05) to produce a per-capita average consumption for the state, then multiplied by the population of each county (from the same U.S. Census data) to estimate total residential usage for each county.
- Commercial usage data for each county was calculated in the same way, with the understanding that a scaling factor other than population would probably produce more accurate estimates. However, the easy availability of population data prompted its use. EIA commercial non-utility fuel includes gasoline; however, because this data is likely to be mostly gasoline usage in lawn and garden equipment, and because lawn and garden gasoline usage is also included in our estimates of non-road mobile sources of emissions, it has been excluded from this sector.
- Given that industrial data is unlikely to scale with population, EPA's Facility Level Information on Greenhouse Gases Tool (FLIGHT) was used to search for large emitters of GHGs associated with the consumption of non-utility fuel. However, only two such sources exist in the region, both cement manufacturing facilities. These facilities produce GHG emissions associated with the consumption of non-utility fuels, as well as emissions associated with the chemical production process.

At both of these facilities, both types of emissions are emitted through a single exhaust stack, making it impossible to separate the two emission sources. These facilities are included in the Process and Fugitive Emissions sector.

» Emissions factors come from the EPA's Emission Factors Hub.

EMISSIONS FACTOR/ YEAR	CO_2 (LBS./MWH)	CH_4 (LBS./GWH)	N_2O (LBS./GWH)	DATA GAPS/ASSUMPTIONS
2019 FPL CPRG	665	55	7	CO_2 from Nextera, CH_4 and N_2O from EPA eGRID

TABLE 9: Emissions Factors for Electricity Consumption

TRANSPORTATION

ON-ROAD TRANSPORTATION

» Annual vehicle miles traveled (VMT) data for each county was provided by Google's Environmental Insights Explorer (EIE). EIE uses Google's proprietary location history data to estimate travel modes and distances. Although the Florida Department of Transportation provides county-level VMT data for counties in Florida, this data is often not available in other states. Where it is available in other states, methodological differences may make it difficult to compare data between counties in different states. EIE data, which covers most of the nation at the county level, allows methodological uniformity across the country and is easily accessed by ICLEI.

» For 2019, passenger vehicle and light-duty truck fuel efficiency data were taken from the Bureau of Transportation Statistics. Heavy-duty truck fuel efficiency data were taken from an EIA report, which has since been deleted.

» For 2021, all vehicle fuel efficiency data was taken from the Federal Highway Administration Highway Statistics Series.

» For both years, minor differences between the data sources and ClearPath factor sets are due to revisions in the source data after the establishment of ClearPath factor sets.

» Emissions factors come from the EPA's Emission Factors Hub.

FUEL	VEHICLE TYPE	MPG	CH_4 (G/MILE)	N_2O (G/MILE)
Gasoline	Passenger Vehicle	24.10	0.0183	0.0083
Gasoline	Light Truck	17.60	0.0193	0.0148
Gasoline	Heavy Truck	5.37	0.0785	0.0633
Gasoline	Motorcycle	24.10	0.0183	0.0083
Diesel	Passenger Vehicle	24.10	0.0005	0.0010
Diesel	Light truck	17.60	0.0010	0.0015
Diesel	Heavy truck	6.39	0.0051	0.0431

TABLE 10: Emissions Factors for Transportation - 2019 U.S. National Defaults (Updated 2021)

AVIATION

- Aviation emissions were estimated based on the total fuel flowage from any regional airport. This was based on the assumption that, on average, planes are fueling to the same level before each inbound and outbound flight. Aviation emissions include emissions that occur outside the region, but are associated with travel to and from the region.
- This inventory includes all aviation gasoline (avgas) and jet fuel (JF) flowage for class B, C, and D airports in the region (Table 11). This is likely to include most aviation emissions in the region without the difficulty of collecting data from a relatively large number of small airfields.
- Data requests were sent to all operators of all airports listed in Table 11. Where an airport supplied data on one type of fuel but not the other, it is unclear whether the data is missing or if the airport does not provide that fuel type.
- Data for Miami Executive Airport and Miami-Opa Locka Airport has been included in previous inventories completed by Miami-Dade County. However, this data was undocumented and negligible enough that it was excluded from this inventory.
- Emissions factors come from the EPA's Emission Factors Hub.

AIRPORT	AIRSPACE CLASS	COUNTY	AVGAS[1]	JET FUEL
Miami International	B	Miami-Dade		×
Fort Lauderdale-Hollywood International	C	Broward		×
Palm Beach International	C	Palm Beach		×
Boca Raton	D	Palm Beach	×	×
Fort Lauderdale Executive	D	Broward	×	×
Key West International	D	Monroe	×	×
Miami Executive	D	Miami-Dade		
Miami Opa-Locka Executive	D	Miami-Dade		
Pompano Beach	D	Broward	×	×

TABLE 11: Airport Data Sources

RAIL, COMMERCIAL MARINE, AND OTHER NON-ROAD

- For other transportation emission estimates, county-level data provided by the EPA via their 2020 National Emissions Inventory (NEI) was used. Although 2020 is likely to be an anomalous year due to the effects of the COVID-19 pandemic, this data was used given its availability.
- In the NEI data retrieval tool, data was filtered to select only GHG as the pollutant and each county as the location. The counties are particularly interested in rail and seaport data.
- For commercial marine emissions, "Marine Vessels, Commercial" for SCC Level 2 was selected, and all data for each county was combined. This data includes port data as well as underway data for activity within 200 miles of the coast.
- For rail, "Railroad Equipment" for SCC Level 2 was selected, and all data not labeled as "Railway Maintenance" for each county was combined.
- For all other non-road transportation and mobile sources, an ICLEI-provided spreadsheet was used to combine all other non-road mobile sources in the NEI database, and combined by fuel type.
- Since the NEI provides emission estimates, no emission factors were necessary.

1 An "×" in the "Avgas" or "Jet Fuel" columns indicates that the airport supplied data for that fuel type.

SOLID WASTE

LANDFILL AND COMBUSTION

» Mass of municipal solid waste landfilled or incinerated by each county was provided by Florida Department of Environmental Protection county solid waste management reports. The 2020 reports, the most recent available, were used for 2021.

» These reports also contain data on waste composition. To match classifications in the reports to the classifications used in ClearPath, we assumed that "Yard Waste" could be divided equally among branches, leaves, and grass and that 25% of "Construction and Demolition" was dimensional lumber.

WASTE TYPE	BROWARD COUNTY	MIAMI-DADE COUNTY	MONROE COUNTY	PALM BEACH COUNTY
Newspaper	2.02%	2.23%	4.40%	2.95%
Office Paper	2.35%	2.30%	0.71%	2.44%
Corrugated Cardboard	5.04%	5.36%	1.03%	7.22%
Magazines/Third Class Mail	13.46%	15.54%	0.37%	18.31%
Food Scraps	10.44%	12.43%	21.05%	16.66%
Grass	0.73%	2.10%	1.37%	1.10%
Leaves	0.73%	2.10%	1.37%	1.10%
Branches	0.73%	2.10%	1.37%	1.10%
Dimensional Lumber	4.72%	5.43%	8.00%	1.64%

TABLE 12: Florida Department of Environmental Protection Waste Characterization for Solid Waste

WASTEWATER

» Water and wastewater data are difficult to obtain due to the high number of operators in the region and variety in treatment processes for wastewater, all of which produce different amounts of different types of greenhouse gas. Additionally, grid electricity usage, which causes all emissions associated with potable water operations and is typically the largest source of emissions associated with wastewater treatment, is already included in utility-supplied grid electricity usage data for the commercial sector. Since the remaining process emissions tend

to be a small fraction of overall community emissions, a simple population-based estimate for wastewater process emissions was employed, making reasonable assumptions about wastewater treatment methods supplemented with actual details on operations where available.

ACTIVITY	DATA SOURCE	DATA GAPS/ASSUMPTIONS
Population	U.S. Census, individual responses from water utilities	Calculations assume that the entire region except Monroe County uses anaerobic processes and nitrification and denitrification, that 34% of wastewater effluent is delivered to the ocean (based on Miami-Dade County data), and that per-capita amounts of flared and combusted digester gas match those of Miami-Dade County

TABLE 13: Wastewater Data Sources

AGRICULTURE, FORESTRY, AND OTHER LAND USE (AFOLU)

FORESTRY AND LAND USE

» Emissions associated with forestry and land use change were calculated by using ICLEI's Land Emissions and Removals Navigator (LEARN) tool. This tool uses data from the U.S. Geological Survey's National Land Coverage Database to estimate changes in land use. Using the tool, data from 2013 to 2019 (the most recent data included in the tool) was compared to estimate land use change. While using a six-year window instead of a three-year window pulls less recent data into the estimate, the longer time frame provides the advantage of a longer period over which to average, smoothing out any anomalous years. Gainesville, Florida was the only Florida community available to use, and was therefore selected as the analogue community.

AGRICULTURE

» Emissions from livestock across the four-county region, as well as from crop cultivation in Broward and Monroe Counties, are expected to be negligible and have been omitted from this inventory. In Miami-Dade and Palm Beach counties, agricultural sources of GHGs include N_2O emissions from nitrogen fertilizers, biological emissions associated with certain crops such as CH_4 from flooded rice fields and N_2O from nitrogen-fixing legumes, CH_4 and N_2O from burning fields, and CO_2 emissions from oxidizing organic soils. Emissions from agricultural fuel use are included under non-road mobile sources in the transportation sector.

» According to the USDA Quickstat tool, Miami-Dade County had 55,206 acres of cropland in 2017 (the most recent year for which data is available), and Palm Beach County had 438,911 acres. Miami-Dade County's soil is assumed to be all mineral soil, and Palm Beach County's soil is assumed to be all organic soil.

Nitrogen Fertilization

» The *UF/IFAS Standardized Fertilization Recommendations for Agronomic Crops* and *UF/IFAS Standardized Nutrient Recommendations for Vegetable Crop Production in Florida* recommend between zero and 240 lb of nitrogen fertilization per acre, depending on the crop. Due to difficulties establishing exact crop types and acreages for crops in Miami-Dade County, it was assumed that nitrogen fertilization occurs at 100 lb (45 kg) per acre for all cropland in Miami-Dade County. *The report Nutritional Requirements and Fertilizer Recommendations for Florida Sugarcane* recommends no nitrogen fertilization of organic muck soil for sugarcane crops, so it was assumed that no nitrogen fertilizer is used in Palm Beach County.

» The default value for nitrogen emissions from synthetic crops is 0.01 kg (N_2O-N), taken from Table 11.1 of Chapter 11 of the *2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 4: Agriculture, Forestry, and Other Land Use*, the conversion from N_2O-N to N_2O is 44/28.

» Emissions from nitrogen fertilizer usage in Miami-Dade County is therefore:

55,206 ac × 45 kg/ac fertilization × 0.01 kg (N_2O-N) × 44/28 = 39,038 kg N_2O,

which is 10,345 $MtCO_2e$.

Rice and Legumes

» According to *Chapter 5 of the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 4: Agriculture, Forestry, and Other Land Use*, daily baseline emissions for North American rice are 0.65 kg CH_4/ha•d (table 5.11), scaling factor for irrigated rice (according to USDA Quickstat, Palm Beach County rice is irrigated) is 0.60 (table 5.12), and default number of days is 139 (table 5.11a). Based on guidance from University of Florida(UF)/IFAS staff, roughly 25,000 acres (10,000 ha) of irrigated rice are cultivated in Palm Beach County. Therefore, the following calculation was used to determine emissions from rice fields in Palm Beach County:

10,000 ha × 0.65 kg CH_4/ha•d × 0.60 × 139 d = 542,000 kg CH_4,

which is 15,200 $MtCO_2e$.

» From the USDA Quickstat tool, Palm Beach County had 6,667 ac, or 2,698 ha of legumes, in 2017. According to the 2023 study *Evaluation of Agricultural Land Use Trends and Outlook in Miami-Dade County, Florida*, Miami-Dade County has 7,555 ac of legumes, or 3,060 ha. The following calculation was used to determine the annual legume emissions in Palm Beach County:

2,698 ha × 1 kg(N_2O-N) × 44/28 = 4,236 kg N_2O

or 1,122 $MtCO_2e$.

and in Miami-Dade County are

3,060 ha × 1 kg(N_2O-N) × 44/28 = 4,804 kg N_2O

or 1,237 $MtCO_2e$.

Field Burning

» Burning of sugarcane fields in Palm Beach County causes emissions of CH_4 and N_2O. The USDA Quickstat tool shows 289,000 ac of sugarcane being grown in 2017. Based on guidance from staff at the U.S. Forest Service, an estimate of 280,000 ac is burnt each year, or 97%. From the USDA Quickstat tool, Palm Beach County produced 11,604,222 tons of sugarcane in 2017. From table 11.1a of *Chapter 11 of the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 4: Agriculture, Forestry, and Other Land Use*, the default residual mass after harvest for perennial grasses is 10%, or 1,604,422 tons, and it was assumed that 97%, or 1,124,284 tons of residue remain in areas that are burned.

» From table 2.6 of *Chapter 2 of the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 4: Agriculture, Forestry, and Other Land Use*, the combustion factor for agricultural sugarcane residue is 0.8. From table 2.5, the emissions factor for burning agricultural residue for CH_4 is 2.7 g/kg and for N_2O is 0.07 g/kg. CH_4 emissions are therefore:

1,124,284 kg × 0.8 × 2.7 g/kg = 2,428,453,000 g CH_4

or 67,997 $MtCO_2e$.

N_2O emissions are:

1,124,284 kg × 0.8 × 0.07 g/kg = 2,428,453,000 g N_2O

or 16,684 $MtCO_2e$, for a total of 84,681 $MtCO_2e$ from field burning.

Oxidizing Soil

» Based on guidance from UF/IFAS staff, approximately 420,000 ac of muck soil is farmed in Palm Beach County. However, 25,000 ac (10,000 ha) of that farmed land is used for rice, which typically reduces soil oxidation rates, leaving 395,000 ac (160,000 ha) of non-rice muck.

» From the *Everglades Foundation's study Carbon Assessment of the Everglades Agricultural Area*, the emission factor for eroding muck soil is 35 $MtCO_2e$/ha. From the *2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands*, table 2.1, the emission factor for tropical rice paddies on drained inland wetlands (recommended by Dr. Tiffany Troxler, co-editor of the Supplement) is 9.4 tons C/ha. This number is converted to CO_2 by a conversion factor of 44/12.

» Soil oxidation emissions from rice areas:

10,000 ha rice × 9.4 t C × 44/12

or 345,000 $MtCO_2e$.

» Soil oxidation emissions from non-rice areas:

160,000 ha × 35 $MtCO_2e$ / ha

or 5,600,000 $MtCO_2e$.

ACTIVITY	EMISSION FACTOR	SOURCE
Fertilizer application	0.01 [kg N_2O - N / kg N]	2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories
Oxidation of muck soil	35 $MtCO_2e$ / ha	Everglades Foundation's Carbon Assessment of the Everglades Agricultural Area
Irrigated rice methane	0.65 kg CH_4 / ha•d	2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories
Field burning	2.7g / kg CH_4; 0.07 g / kg N_2O	2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories

TABLE 14: Agriculture, Forestry, and Other Land Use Emission Factors

PROCESS AND FUGITIVE

INDUSTRIAL FACILITIES

» EPA's Facility Level Information on Greenhouse Gases Tool (FLIGHT system) was used to capture emissions from large industrial facilities. The only two sources found were both cement manufacturing facilities in Miami-Dade County. These facilities both have a combined stack, and therefore process and combustion emissions were included. Any combustion emissions should typically be included in the industrial sector, but since they cannot be separated from process emissions, they are included here within Process and Fugitive emissions. Any utility-supplied natural gas combusted at these facilities will be double-counted with industrial sector utility-supplied natural gas, however this overlap is negligible.

FUGITIVE GASES

» Emissions of refrigerants, fire suppressants, aerosols, foams, solvents, and SF6 were allocated from state-level data obtained from the EPA Greenhouse Gas Inventory Data Explorer. Emissions of SF6 are allocated based on electricity usage, because electrical distribution transformers are the source of these emissions. Emissions from refrigerants, fire suppressants, aerosols, foams, and solvents are allocated based on population.

SOUTHEAST
FLORIDA REGIONAL
CLIMATE
CHANGE
COMPACT

FOR MORE INFORMATION, VISIT:

SOUTHEASTFLORIDACLIMATECOMPACT.ORG

FOR MORE ON THE INSTITUTE FOR SUSTAINABLE COMMUNITIES:
SUSTAIN.ORG

IMPLEMENTATION
SUPPORT PROVIDED BY:

INSTITUTE FOR
Sustainable
Communities