

REGIONAL GREENHOUSE GAS INVENTORY: TRANSPORTATION AND STATIONARY ENERGY

METHODOLOGY REPORT



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Inventory Overview

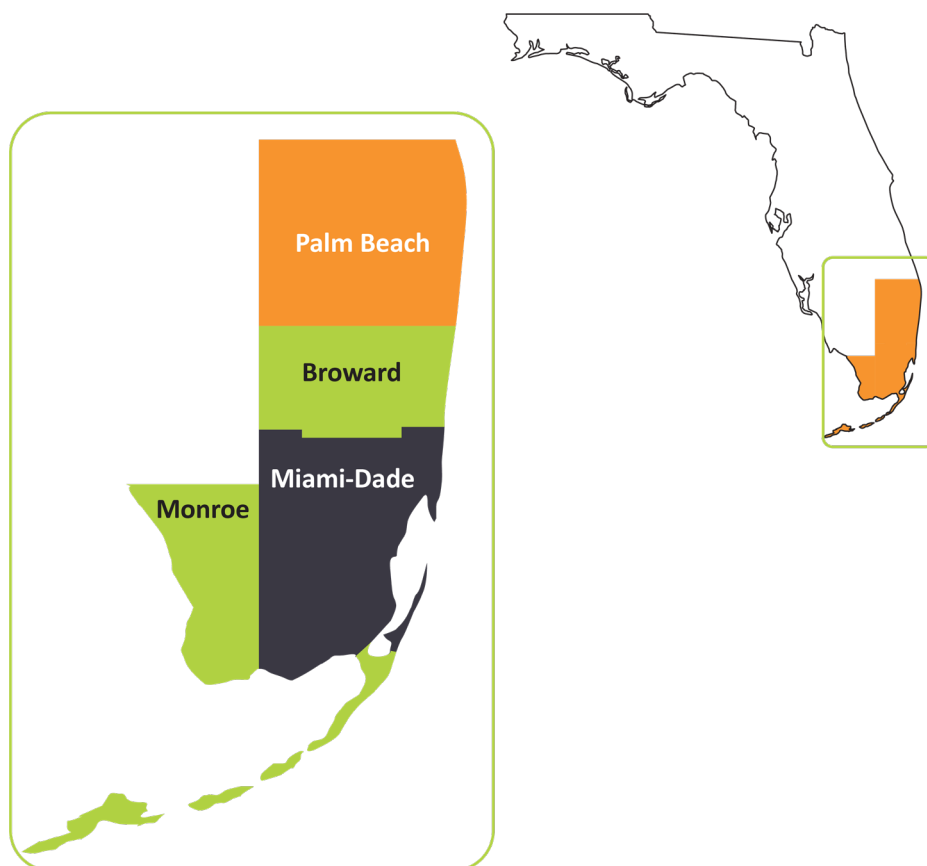
This report describes the methodology used for conducting an inventory of greenhouse gas (GHG) emissions across the Southeast Florida Regional Climate Change Compact (the Compact) region, inclusive of Broward, Miami-Dade, Monroe, and Palm Beach counties for the 10-year period between 2005 and 2015.

The Southeast Florida Regional Climate Change Compact aims to foster sustainability and climate resilience at a regional scale. Through the establishment of the Compact, 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. A regional greenhouse gas emissions inventory is integral to developing informed climate change mitigation strategies and monitoring the region's progress over time.

This 10-year regional GHG inventory was prepared by the [Institute for Sustainable Communities](#) (ISC) on behalf of the Southeast Florida Regional Climate Change Compact. Since 2009, ISC has provided implementation support for Compact activities to advance climate change adaptation and mitigation across the region, serving as a strategic and technical advisor and a neutral facilitator of the Compact.

INVENTORY REGION

The Compact region includes the four counties (Broward, Miami-Dade, Monroe, and Palm Beach) and 109 municipalities in Southeast Florida. The region represents over six million people.



Methodology Overview

This inventory generally follows the accounting guidance in the [U.S. Protocol for Community-Scale Greenhouse Gas Emissions Inventories](#), published by Local Governments for Sustainability (ICLEI USA). This protocol is specifically geared toward conducting a GHG emissions inventory at the community scale in the United States and includes emissions from businesses, residents, and transportation.

This is an *activity-based inventory* that captures the primary sources of emissions within the regional boundary that can be reduced through the actions of local governments and regional entities. In contrast, a *consumption-based inventory* would account for emissions that occur outside a jurisdictional boundary as a result of activities taking place within that jurisdictional boundary.

INVENTORY SCOPE

The regional inventory is a retrospective of 10 years of community-wide emissions of predominant major greenhouse gases: carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O), from 2005 to 2015. Because this inventory follows ICLEI's U.S. Community-Scale Protocol, this inventory does not include all activities within the Southeast Florida region that drive an increase or decrease in atmospheric GHG emissions. Rather than trying to account for every source of emissions, this approach focuses on monitoring progress on the largest emissions sources that can most directly be influenced by local government actions. Therefore, the inventory scope focused on sectors at the regional scale, inclusive of transportation and stationary energy sources.

- **Transportation:** gas and natural gas consumed from on-road transportation, passenger rail, freight rail
- **Stationary Energy:** electricity and natural gas consumed by residential, commercial, and industrial buildings

All emissions are either produced from sources located within the regional boundary (Scope 1) or as a result of grid-supplied electricity, heat, or steam consumed within the region (Scope 2).

Total emissions data reported in this inventory should be considered within the context of this scope, as it may differ from other inventories. The U.S. Protocol defines a minimum set of five "Basic Emissions Generation Activities" that must be included in all protocol-compliant GHG emissions inventory reports:

- Use of electricity
- Use of fuel in residential and commercial stationary combustion
- On-road passenger and freight transportation
- Use of energy in potable water and wastewater treatment
- Generation of solid waste

Wastewater treatment and waste generation emissions were not included in the scope of this inventory. The wastewater and waste management facilities in the Southeast Florida region are owned and operated by individual governments, so any emission reduction efforts were deemed to be wholly within the domain of those individual governments and not a "regional issue."

Because the inventory does not include those two emission activities, this inventory is not U.S. Protocol compliant.

Global Warming Potential

This inventory uses the [*Intergovernmental Panel on Climate Change \(IPCC\) 5th Assessment, 100 year values*](#) for global warming potentials to calculate GHG emissions. The Global Warming Potential (GWP) allows the comparison of how much heat different greenhouse gases trap in the atmosphere relative to carbon dioxide. The three major greenhouse gases emitted by human activities (carbon dioxide, methane, and nitrous oxide) and included in this inventory can be expressed in terms of CO₂-equivalents (CO₂e). 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 (CO₂). The larger the GWP, the more that a given gas warms the Earth compared to CO₂ over that time period. As atmospheric and climate science findings evolve, the GWP of each gas has been updated to better reflect the global warming impact of emissions.

GLOBAL WARMING POTENTIAL (GWP) VALUES RELATIVE TO CO₂ (100-YEAR TIME HORIZON)

GHG NAME	CHEMICAL FORMULA	IPCC FIFTH ASSESSMENT (AR5)
Carbon dioxide	CO ₂	1
Methane	CH ₄	28
Nitrous Oxide	N ₂ O	265

Inventory Platform & Data Sources

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 U.S.

Data Sources

Energy and fuel consumption data for the inventory came from local utilities, state agencies, and transportation companies (listed below). The included utilities cover the majority of emissions within each category. A few data sources did not respond to data requests, and were therefore not included: Florida City Gas (Stationary Energy, Natural Gas) and Florida East Coast Railway (FEC). The Compact staff determined that emissions from these sources were minimal and would not significantly change the trends of the 10-year inventory.

DATA TYPE	DATA PROVIDED	DATA SOURCES
Transportation: On-road Vehicles	Vehicle Miles Traveled	<ul style="list-style-type: none"> Florida Department of Transportation Travel Data and Analytics Office
Transportation: Off-road - Rail	Fuel Consumed (gallons)	<ul style="list-style-type: none"> Amtrak (passenger) Tri-Rail (passenger) CSX Transportation (freight)
Stationary Energy: Electricity	Electricity Consumption (MwH)	<ul style="list-style-type: none"> Florida Power and Light (Broward, Miami-Dade, Palm Beach counties) Keys Energy Services (Monroe County) Florida Keys Electric Cooperative (Monroe County) Homestead Public Services (Miami-Dade County)
Stationary Energy: Natural Gas	Natural Gas Consumption (therms)	<ul style="list-style-type: none"> TECO Peoples Gas

Whenever possible, emission factors and assumptions provided by each data source were applied to emissions calculations. If unavailable, the most local assumptions available (regional and state) were applied. All other factors followed ICLEI standard assumptions provided through ClearPath.

Transportation Emissions

ON-ROAD

Transportation emissions from on-road transportation were calculated using vehicle miles traveled (VMT) data for the Southeast Florida region. VMT data for Broward, Miami-Dade, Monroe, and Palm Beach counties was gathered from Florida Department of Transportation for the years 2005-2015, by fiscal year. Because a local vehicle fleet mix was not readily available for the Southeast Florida region, ICLEI ClearPath standard was used to define the percentage of different vehicle types.

Emission factors for major greenhouse gases (CO₂, CH₄, and N₂O) by vehicle type were calculated using data from U.S. Environmental Protection Agency (EPA) [Inventory of U.S. Greenhouse Gas Emissions and Sinks](#) (2005-2015 reports). At the time of calculations, ClearPath did not include emission factors for all 10 years covered in this inventory, therefore emission factors for 2005-2010 were calculated. To calculate inventory year emission factors, VMT distribution of each vehicle age was first applied to regional VMT to determine the ratio of vehicle ages represented in Southeast Florida data. Because each vehicle age has a different ratio of emission control technologies, which result in different emission factors, inventory year emission factors of CH₄ and N₂O were calculated by pro-rating emission factors of control technologies to the percent of each vehicle age on the road for every inventory year.

Average fuel economy assumptions for gasoline vehicles were based on federal standards reported by the U.S. Department of Transportation's Bureau of Transportation Statistics (BTS). Given BTS does not report diesel fuel economy, gasoline fuel economy standards were converted to diesel with a conversion rate of 1.13 gallons of low-sulfur diesel to 1 gallon of gasoline, as reported by the U.S. Department of Energy Alternative Fuels Data Center, in order to calculate diesel fuel economy.

Limitations

The ClearPath vehicle fleet mix assumption likely does not fully reflect the true vehicle fleet mix in Southeast Florida. The assumed fleet mix in ClearPath does not reflect likely annual changes in the types of vehicles on the road, and only includes passenger vehicles, light trucks, and heavy trucks, in gasoline and diesel. It does not include electric or hybrid vehicles, nor does it include motorcycles. Therefore, the on-road emissions calculations do not capture consumer shifts toward lower-emission vehicles or electric vehicle deployment. In the future, the Compact may consider investing in collecting regionally-specific annual vehicle fleet mixes in order to capture those dynamics.

BTS also reports that the Federal Highway Administration (FHA) changed its methods in 2011 for classifying vehicles for VMT and fuel economy estimates, moving from a classification system based on vehicle body type to one based on wheelbase. BTS applied those classifications to several years retroactively, but only through 2007. Therefore, BTS notes that fuel economy data is not comparable before and after 2007. ClearPath does, however, include pre-2007 data in their assumptions and does not note the methodology change, so ISC staff followed ClearPath assumptions. This will not be a limitation in future inventories, as future inventories will likely be conducted within the timeframe of the new FHA classification.

RAIL

Transportation emissions from passenger transit and freight rail were calculated based on the gallons of fuel consumed by each railway within the four-county region during this inventory period: Amtrak, Tri-

Rail, and CSXT. Calculations were based on the type of fuel used: Amtrak and CSXT reported the fuel type as diesel for all 10 years. Tri-Rail reported different fuel mixes over the 2005-2010 period, showing an increased percentage of B20, B99, and ultra-low-sulfur diesel over time.

ClearPath assumptions for diesel emission factors were used to calculate Amtrak and CSXT emissions. Since ClearPath does not have a structure to embed different annual emission factors for rail fuel, Tri-Rail emissions were calculated separately from ClearPath. To calculate Tri-Rail emissions, U.S. EPA Emission Factors for Greenhouse Gas Inventories (updated 2014) were used to determine the emissions factors of component fuels in the Tri-Rail fuel mix. Those factors were then weighted against the fuel percentages to determine an annual emission factor for Tri-Rail data. Only 2008 and 2009 had a rail fuel emission factor different than the standard diesel emissions factor.

Limitations

The Compact was unable to retrieve data from the Florida East Coast railway, so this inventory does not include freight rail data from that source. Due to changes in their data storage, Tri-Rail did not have 2010 data for Broward or Palm Beach counties. It can be assumed that total rail transportation emissions are slightly higher than currently reported. However, because rail transportation accounts for a small percentage of overall emissions, neither omission significantly alters inventory results.

Stationary Energy Emissions (Residential, Commercial, and Industrial)

ELECTRICITY

Emissions from electricity consumed by stationary sources (residential, commercial, and industrial) were calculated based on data from several electric utilities. Florida Power & Light (FP&L), the primary energy utility in the region, provided consumption data for Broward, Miami-Dade, and Palm Beach counties, parsed by sector. Monroe County electricity data was provided by the two utilities serving that region: Keys Energy Services and Florida Keys Energy Cooperative. Monroe County staff provided guidance for sorting utility-specific categories into the broader sector categories. Additionally, Homestead Public Services, a municipal-owned utility, provided data for the City of Homestead in Miami-Dade County.

Emissions were calculated using utility-specific emission factors when provided. FP&L provided emission factors for each year of the 10-year period based on changes in their production and purchasing. The FP&L emission factors were also applied to Florida Keys Energy Cooperative consumption data, since the utility purchases wholesale power from FP&L. The EPA's [Emissions & Generation Resource Integrated Database](#) (eGrid2005-eGrid2014) for the Florida Reliability Coordinating Council region were applied to data from the Keys Energy Services and Homestead Public Services. EGrid Data is only available for years 2005, 2007, 2009, 2010, 2012, and 2014, therefore, the emission factors for the inventory years not published were estimated by taking the average between preceding and following years.

Limitations

The Compact was unable to retrieve data from the Lake Worth municipal utility. However, given the limited service region of the municipal utility comparative to the overall region, the emissions associated with that omission would not significantly alter the overall electricity emissions for the region.

NATURAL GAS

Emissions from natural gas consumed by stationary sources (residential, commercial, and industrial) were calculated based on data provided by natural gas companies. TECO energy provided natural gas consumption for Broward, Miami-Dade, and Palm Beach counties, parsed by sector. Emissions were calculated by applying the standard emission factors in ClearPath for natural gas.

Limitations

Florida City Gas, which services portions of Broward, Miami-Dade, and Palm Beach counties, did not provide the Compact natural gas consumption data for the region.

Appendix A: Total Emissions Data

SOUTHEAST FLORIDA REGIONAL EMISSIONS (METRIC TONS CO₂E)

YEAR	TRANSPORTATION	COMMERCIAL ENERGY	INDUSTRIAL ENERGY	RESIDENTIAL ENERGY	TOTAL
2005	24,445,608	13,299,759	817,895	14,891,163	53,454,425
2006	24,411,291	12,233,802	760,431	13,445,573	50,851,097
2007	24,591,241	12,803,248	726,589	13,835,909	51,956,987
2008	23,318,986	12,172,116	641,641	12,818,682	48,951,425
2009	23,137,986	11,931,781	584,771	12,754,140	48,408,678
2010	21,659,043	11,676,574	545,564	12,796,041	46,677,222
2011	22,988,026	11,618,602	526,880	12,353,582	47,487,090
2012	23,055,964	11,984,493	544,815	12,456,760	48,042,032
2013	22,767,580	11,337,536	519,313	11,808,685	46,433,114
2014	23,720,989	10,930,296	495,558	11,504,030	46,650,873
2015	23,582,577	11,572,930	531,052	12,562,503	48,249,062
Average	23,425,390	11,960,103	608,592	12,838,824	48,832,910
Average % of Total	48.0%	24.5%	1.2%	26.3%	

Appendix B: Per Capita Emissions Data

SOUTHEAST FLORIDA REGIONAL EMISSIONS - PER CAPITA (METRIC TONS CO₂E)

YEAR	TOTAL EMISSIONS	TOTAL POPULATION	PER CAPITA EMISSIONS
2005	53,454,425	5,519,294	9.69
2006	50,851,097	5,540,847	9.18
2007	51,956,987	5,538,603	9.38
2008	48,951,425	5,575,050	8.78
2009	48,408,678	5,620,216	8.61
2010	46,677,222	5,658,818	8.25
2011	47,487,090	5,780,226	8.22
2012	48,042,032	5,862,905	8.19
2013	46,433,114	5,937,602	7.82
2014	46,650,873	6,013,958	7.76
2015	48,249,062	6,089,813	7.92

Appendix C: Emission Factors and Data Sources

ELECTRICITY — FRCC

GHG	UNIT	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
CO ₂	lb/MWh	1,318.57	1,269.34	1,220.11	1,198.36	1,176.61	1,196.71	1,161.03	1,125.35	1,107.03	1,088.70	1,088.70
CH ₄	lb/GWh	45.92	43.56	41.19	40.22	39.24	38.91	39.48	40.05	64.23	88.40	88.40
N ₂ O	lb/GWh	16.94	16.10	15.25	14.39	13.53	13.75	12.80	11.85	11.98	12.10	12.10

Sources: US EPA - EGrid Data Summary, FRCC region <https://www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid-questions-and-answers#egrid4b>

Notes: EPA EGrid Data is available for years 2005, 2007, 2009, 2010, 2012, 2014. In order to fill-in the missing years for the full inventory years, the average between the surrounding years was calculated.

ELECTRICITY — FLORIDA POWER & LIGHT (FP&L)

GHG	UNIT	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
CO ₂	lb/MWh	976	878	896	851	845	818	799	820	768	733	752
CH ₄	lb/GWh	87.8	87.8	87.8	87.8	87.8	87.8	87.8	87.8	87.8	87.8	87.8
N ₂ O	lb/GWh	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1

Sources: Florida Power & Light

Notes: From FP&L: CO₂ rate from FP&L system-wide actual performance; CH₄ and N₂O from EPA's eGRID 2014 emissions factors for electricity use.

ELECTRICITY — NATURAL GAS (TECO)

GHG	UNIT	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
CO ₂	kg/MMBtu	53.020	53.020	53.020	53.020	53.020	53.020	53.020	53.020	53.020	53.020	53.020
CH ₄	kg/MMBtu	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
N ₂ O	kg/MMBtu	1 x10 ⁻⁴	1 x10 ⁻⁴	1 x10 ⁻⁴	1 x10 ⁻⁴	1 x10 ⁻⁴	1 x10 ⁻⁴	1 x10 ⁻⁴	1 x10 ⁻⁴	1 x10 ⁻⁴	1 x10 ⁻⁴	1 x10 ⁻⁴

Sources: ICLEI

Notes: ClearPath built-in assumption for natural gas

TRANSPORTATION — OFF-ROAD RAIL (TRI-RAIL)

GHG	UNIT	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
	Fuel Type ¹	Diesel	Diesel	50% Low Sulfur Diesel; 50% Diesel	80% Diesel; 16% B20; 4% B99	52% B20; 48% Diesel	Diesel	Diesel	Ultra Low Sulfur Diesel	Ultra Low Sulfur Diesel	Ultra Low Sulfur Diesel	Ultra Low Sulfur Diesel
CO ₂	kg/gallon ²	10.21	10.21	10.21	D = 10.21 BD = 9.45	D = 10.21 BD = 9.45	10.21	10.21	10.21	10.21	10.21	10.21

Sources: 1 Tri-Rail

2 US EPA https://www.epa.gov/sites/production/files/2015-07/documents/emission-factors_2014.pdf

Notes: Emissions calculated by hand and entered directly, since ClearPath does not have a mechanism for creating “rail” transportation factor sets. Emissions for each fuel type were weighted by annual fuel mix. Tri-Rail did not provide fuel type for 2010 and 2011, so diesel fuel was assumed

TRANSPORTATION — OFF-ROAD RAIL DIESEL

GHG	UNIT	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
CO ₂	MT/MMBtu	0.074	0.074	0.074	0.074	0.074	0.074	0.074	0.074	0.074	0.074	0.074
CH ₄	MT/MMBtu	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
N ₂ O	MT/MMBtu	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Sources: ICLEI

Notes: ClearPath built-in assumption for rail diesel

TRANSPORTATION — ON-ROAD VEHICLES

CATEGORY	GHG	UNIT	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Gas Passenger Vehicle	CH ₄	g/mi	0.031	0.028	0.026	0.024	0.022	0.020	0.019	0.019	0.020	0.020	0.019
Gas Passenger Vehicle	N ₂ O	g/mi	0.032	0.030	0.026	0.023	0.020	0.017	0.014	0.012	0.015	0.013	0.011
Gas Light Truck	CH ₄	g/mi	0.038	0.032	0.029	0.026	0.026	0.025	0.023	0.022	0.024	0.022	0.021
Gas Light Truck	N ₂ O	g/mi	0.054	0.043	0.038	0.032	0.031	0.028	0.025	0.022	0.025	0.022	0.019
Diesel Passenger Vehicle	CH ₄	g/mi	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.000	0.001
Diesel Passenger Vehicle	N ₂ O	g/mi	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Diesel Light Truck	CH ₄	g/mi	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Diesel Light Truck	N ₂ O	g/mi	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Diesel Heavy Truck	CH ₄	g/mi	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Diesel Heavy Truck	N ₂ O	g/mi	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005

Sources: US EPA — Inventory of U.S. Greenhouse Gas Emissions and Sinks (2005 - 2015 reports) <https://www.epa.gov/ghgemissions/us-greenhouse-gas-inventory-report-archive>

Notes: Annual emission factors for VMT were calculated using data included in report methodological annexes: percent of miles by vehicle age; percent of control technology for each vehicle year and vehicle type; and emissions associated with each control technology. Calculated only the vehicle categories that were represented in the ClearPath standard vehicle mix in "ClearPath Vehicle Mix."

TRANSPORTATION — ON-ROAD FUEL ECONOMY

CATEGORY	UNIT	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Gasoline Passenger Cars ¹	MPG	22.1	22.5	22.9	23.7	23.5	23.3	23.2	23.3	23.4	23.2	23.9
Gasoline Light Trucks ¹	MPG	17.7	17.8	17.1	17.3	17.3	17.2	17.1	17.1	17.2	17.1	17.3
Gasoline Heavy Trucks ¹	MPG	8.3	8.2	7.4	7.4	7.4	7.3	7.3	7.3	7.3	7.3	7.4
Gasoline Transit Bus ¹	MPG	6.2	5.9	7.2	7.2	7.2	7.2	7.1	7.2	7.2	7.2	7.3
Gasoline Para Transit Bus ¹	MPG	6.2	5.9	7.2	7.2	7.2	7.2	7.1	7.2	7.2	7.2	7.3
Gasoline Motorcycle ¹	MPG	55.3	54.5	45.1	42.5	43.2	43.4	43.5	43.5	43.5	43.5	43.8
Diesel Passenger Cars ²	MPG	25.0	25.4	25.9	26.8	26.6	26.3	26.2	26.3	26.4	26.2	27.0
Diesel Light Trucks ²	MPG	20.0	20.1	19.3	19.5	19.5	19.4	19.3	19.3	19.4	19.3	19.5
Diesel Heavy Trucks ²	MPG	9.4	9.3	8.4	8.4	8.4	8.2	8.2	8.2	8.2	8.2	8.4

Sources: 1 US Department of Transportation, Bureau of Transportation Statistics

2 US Department of Energy, Alternative Fuels Data Center <https://afdc.energy.gov/fuels/properties>

Notes: Diesel fuel economy was calculated based on gasoline fuel economy using a conversion rate of 1.13

Gasoline Passenger Cars = “Light Duty Vehicle, short wheel base” in Bureau of Transportation Statistics

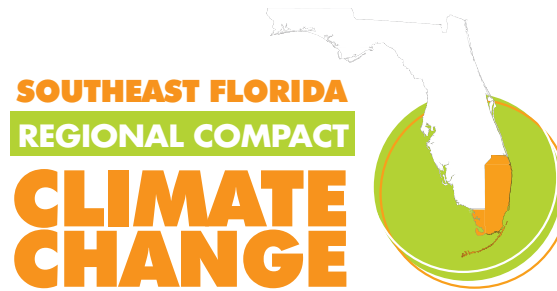
Gasoline Light Trucks = “Light Duty Vehicle, Long wheel base” in Bureau of Transportation Statistics

TRANSPORTATION — ON-ROAD VEHICLE FLEET MIX

CATEGORY	PERCENT
Gas Passenger Vehicle	60.60%
Gas Light Truck	32.40%
Diesel Passenger Vehicle	0.30%
Diesel Light Truck	1.30%
Diesel Heavy Truck	5.40%

Sources: ICLEI

Notes: ClearPath built-in assumptions on vehicle fleets (all years)



For more information, visit:

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