

# U.S. Transportation Greenhouse Gas Emissions: Trends, Uncertainties and Methodological Improvements



John Davies  
U.S. Environmental Protection Agency  
Office of Transportation and Air Quality  
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# Overview

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- **Characterize the magnitude of growth in transportation GHG emissions, based on data from EPA *Inventory of U.S. Greenhouse Gas Emissions and Sinks***
- **Discuss factors affecting the rise in transportation GHGs**
- **Describe sources of uncertainty in the *Inventory* transportation estimates**
- **Discuss methodological improvements**

## *Inventory of U.S. GHG Emissions and Sinks – Institutional Responsibilities*

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- **Prepared annually by EPA under United Nations Framework Convention on Climate Change (UNFCCC)**
- **Coordinated by EPA Office of Atmospheric Programs (OAP)**
- **Includes transportation estimates developed by EPA Office of Transportation and Air Quality (OTAQ)**
- **Relies extensively on data provided by the Energy Information Administration (EIA) of the U.S. Department of Energy**

# *Inventory of GHG Emissions and Sinks –* Document Organization

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- **GHG data are oriented around specific gases (CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O, HFCs)**
  - UNFCCC guidelines also require presentation of GHG data by broad categories (fossil fuel combustion, non-energy use of fuel, etc.)
  - Primary value to climate specialists
- **EPA disaggregates estimates by economic sector, relying heavily on EIA estimates for CO<sub>2</sub> emissions**
- **OTAQ further disaggregates transportation GHG estimates by mode (passenger cars, light-duty trucks, heavy-duty trucks, aircraft, rail, ships/boats)**
- **OTAQ also generates bottom-up estimates of CH<sub>4</sub> and N<sub>2</sub>O**

# *Inventory* accounting Transportation GHGs

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## **Included**

- Tailpipe emissions (from use of energy to power vehicles)
- HFCs from mobile air conditioners

## **Not included**

- Ozone-depleting substances, which are not counted in national totals
- Lifecycle GHGs

## **Estimated, but not counted in transportation total**

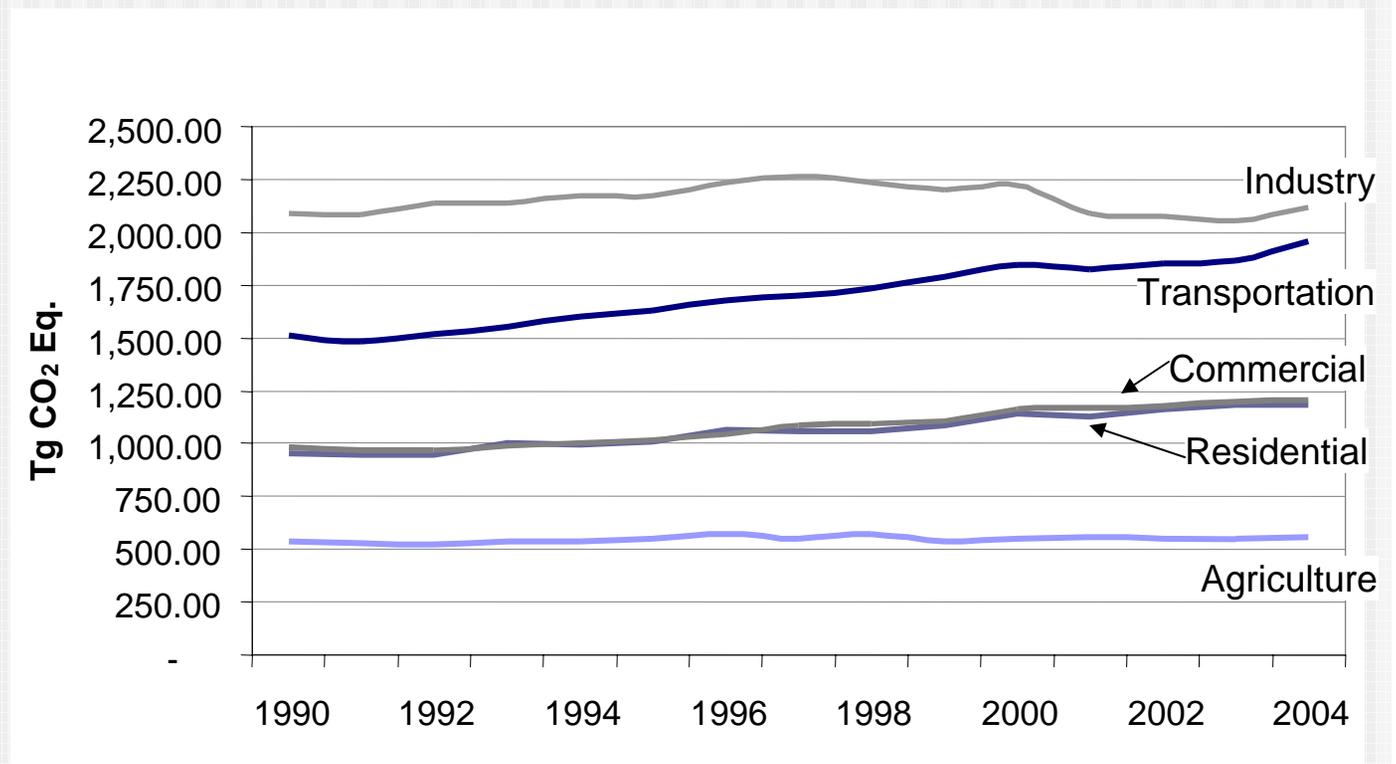
- Agriculture and construction equipment (generally represented in the industrial sector)
- International bunker fuels
  - Reported in Inventory
  - *Not* included in national GHG totals or transportation estimates

# U.S. GHG Emissions by End-Use Economic Sector, 1990-2004

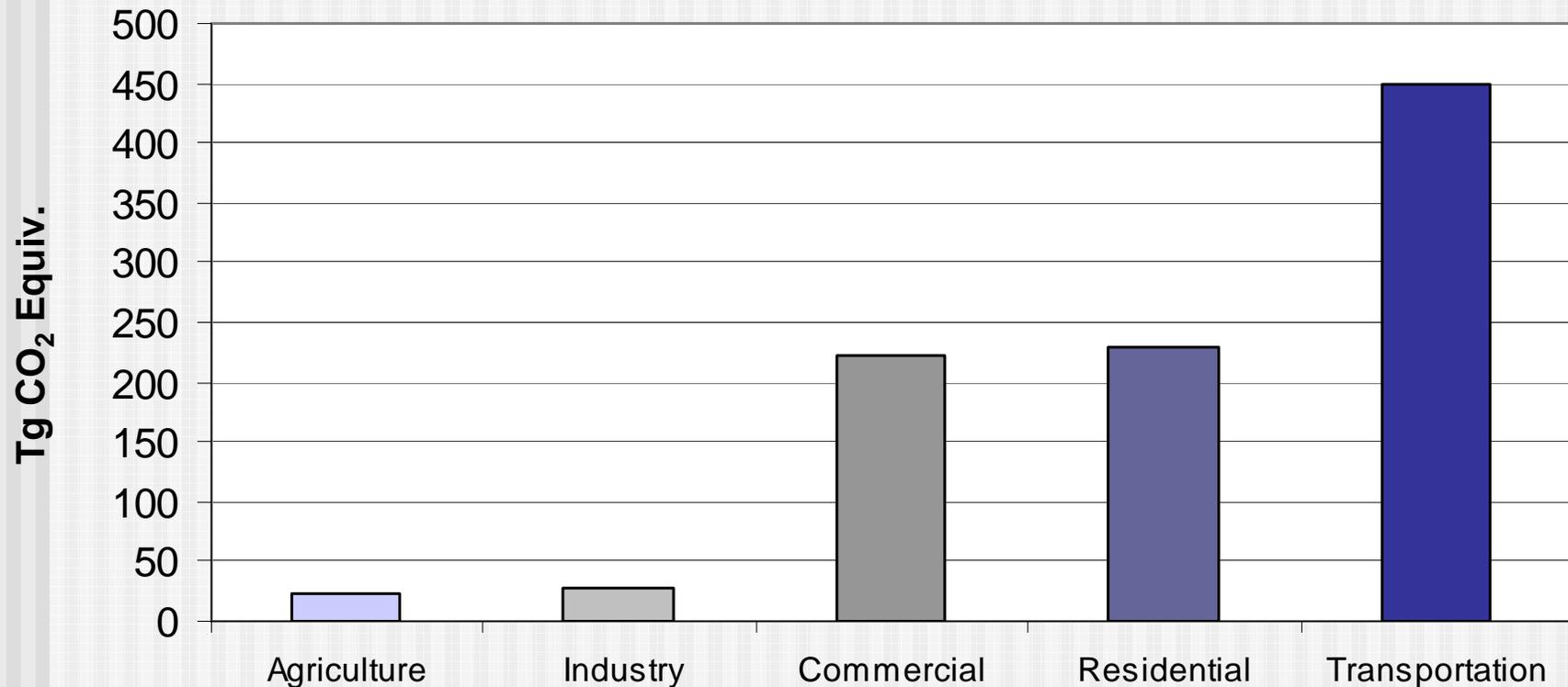
**Transportation GHGs up 29 percent**

**Non-transportation sectors cumulatively up 9.5 percent**

**Transportation accounted for almost 28 percent of U.S. GHGs in 2004**



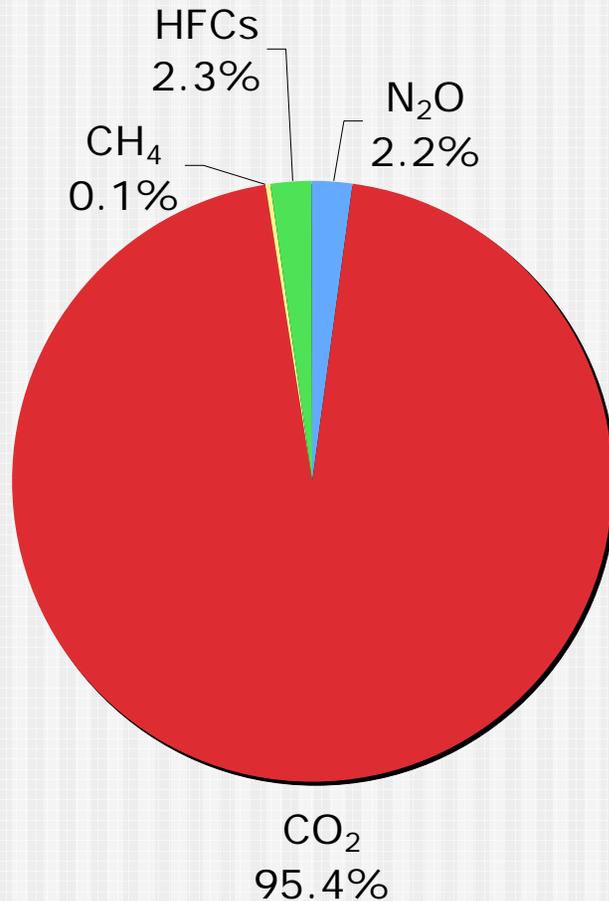
# Change in U.S. GHG Emissions by End-Use Economic Sector, 1990-2004



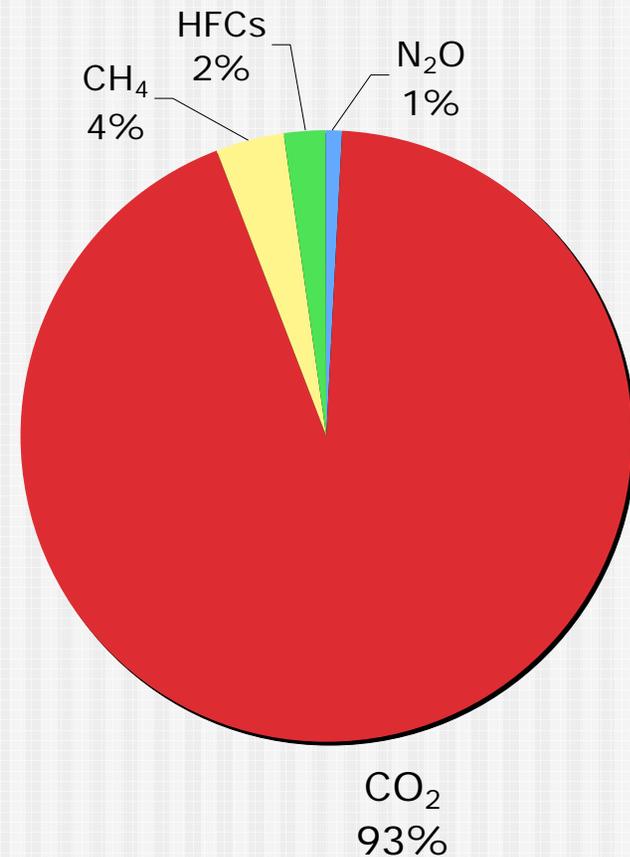
# U.S. GHG Emissions by Gas, 2004

(Weighted by Global Warming Potential)

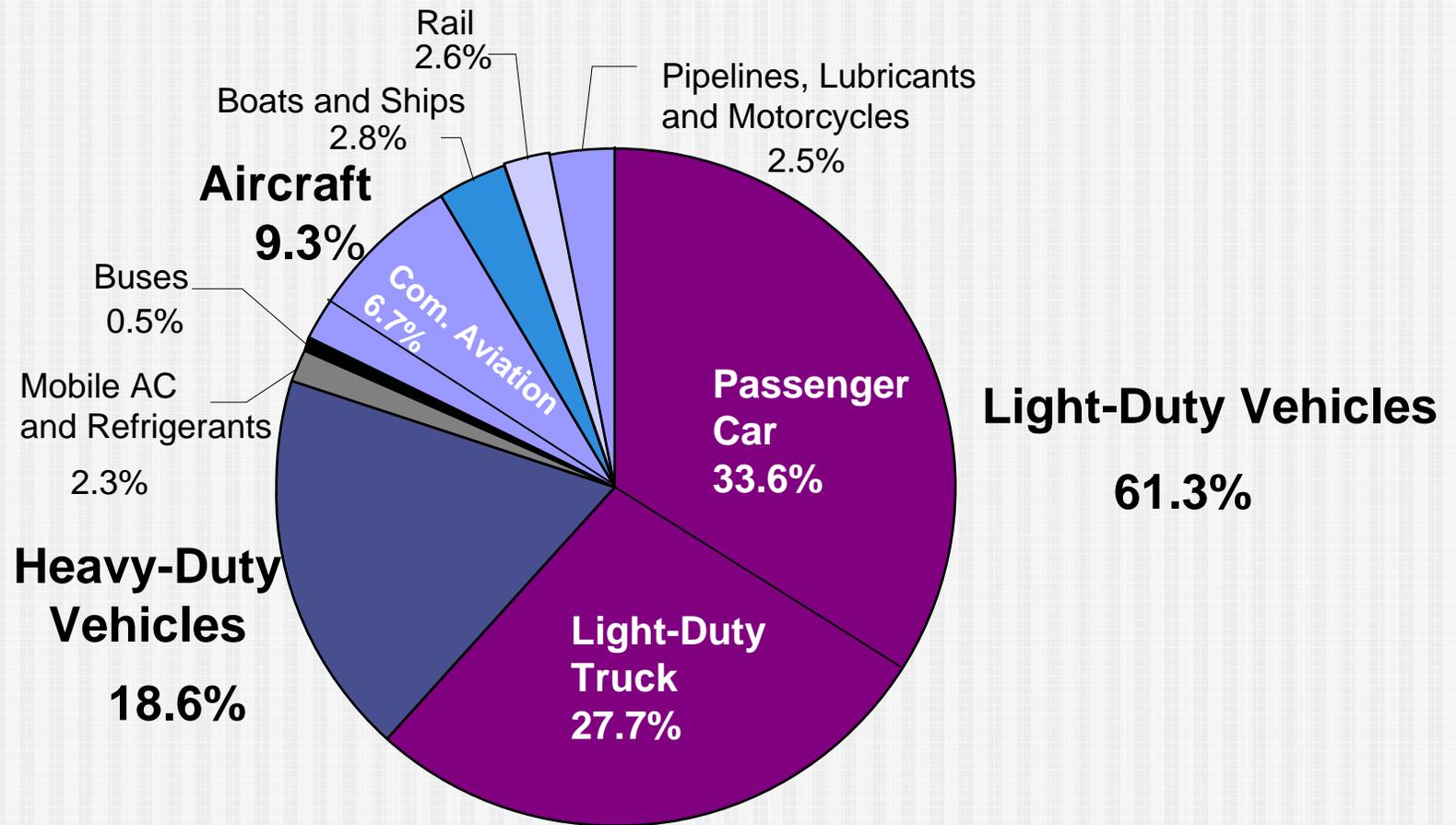
### Transportation



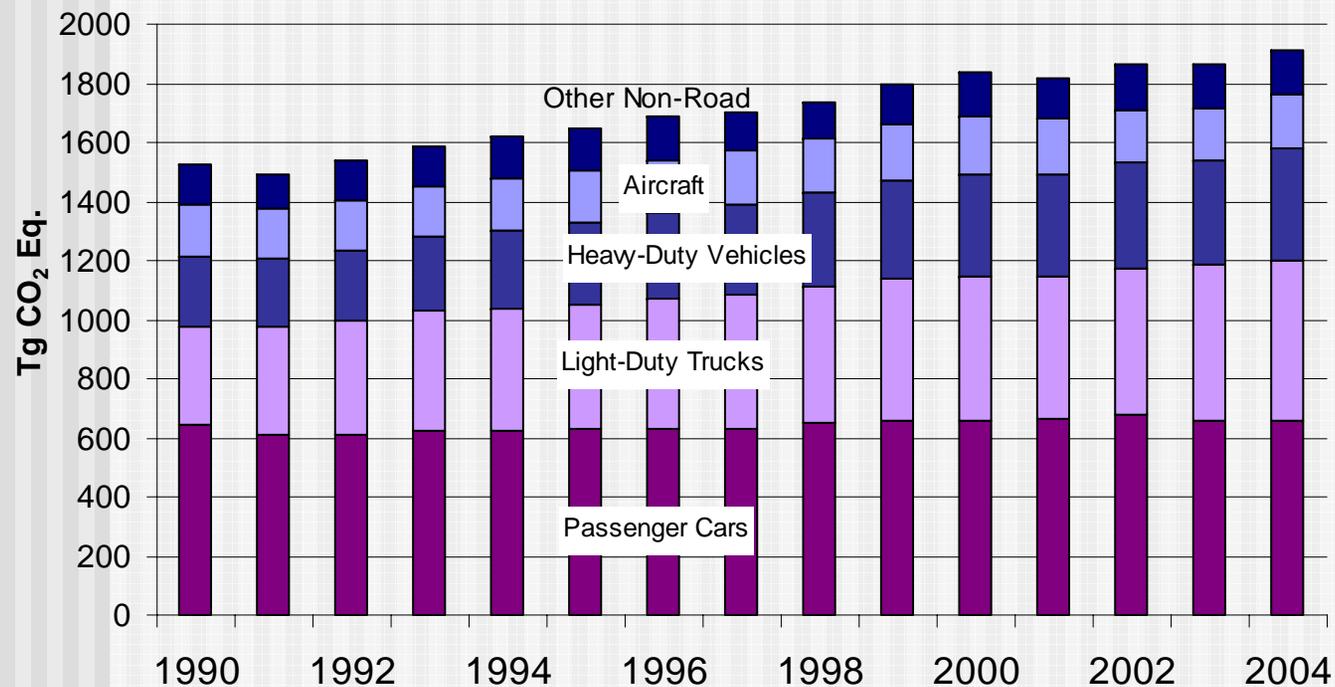
### All Sources



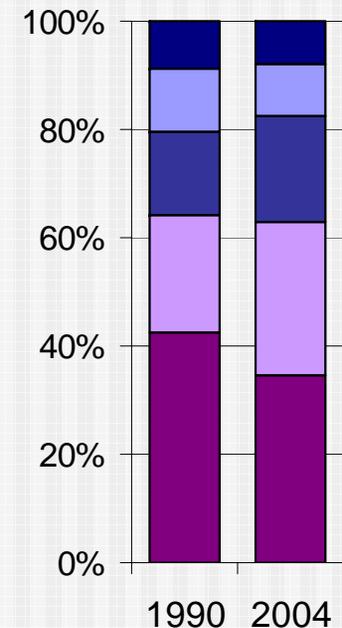
# Sources of U.S. Transportation GHG Emissions in 2004



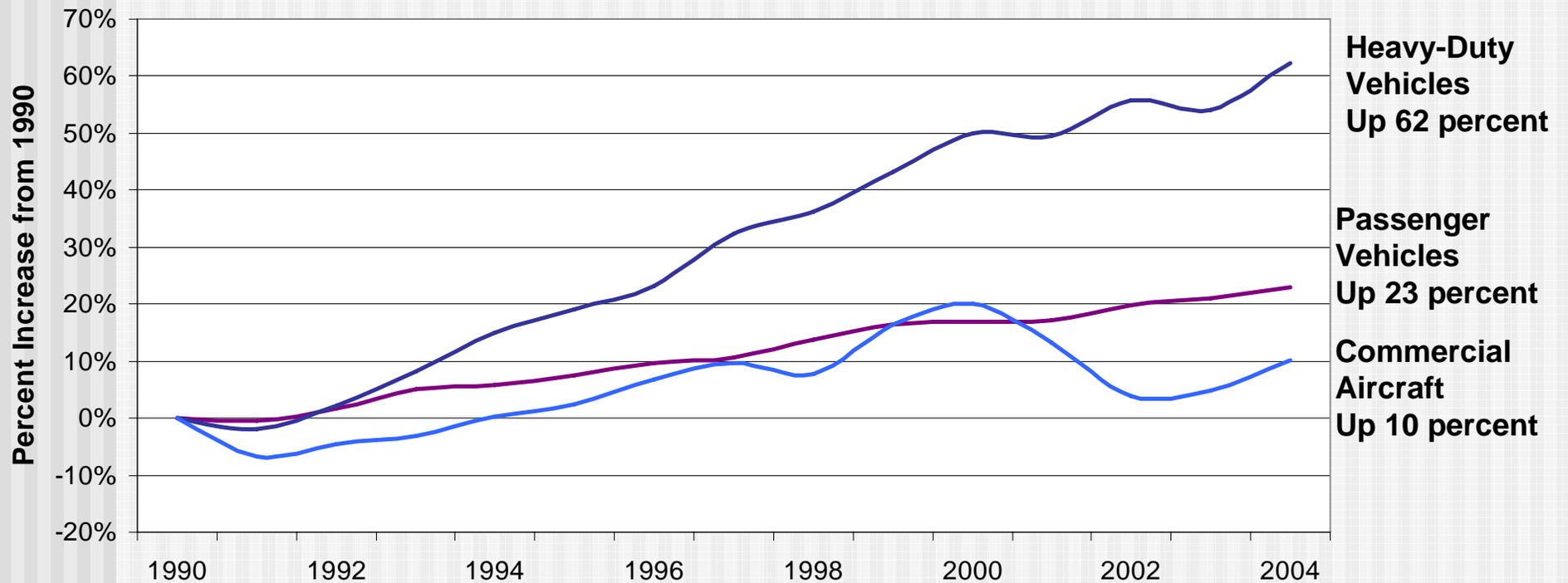
# Transportation GHG Emissions by Source, 1990-2004



Share of Transportation GHGs



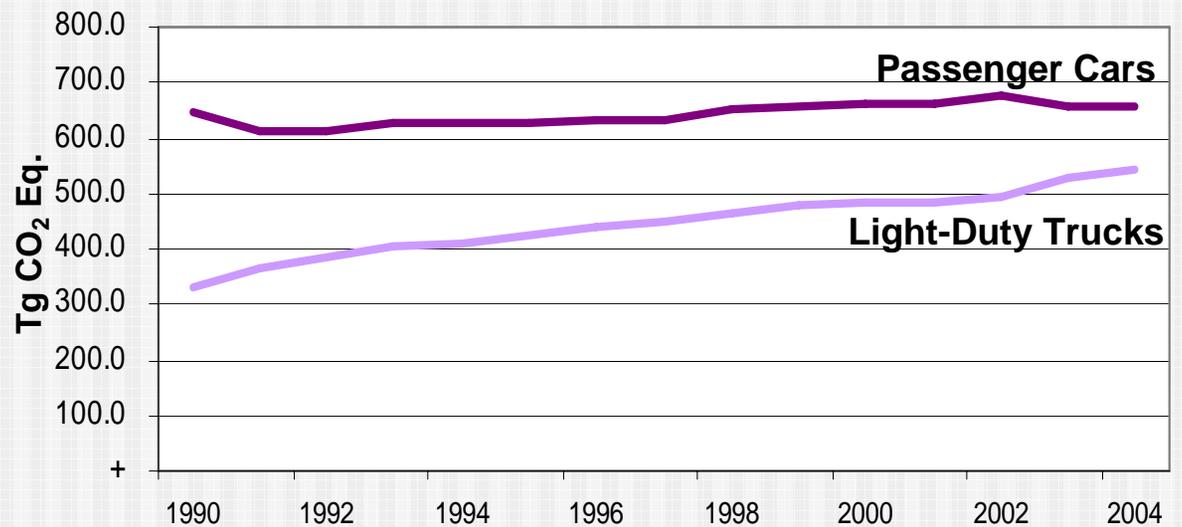
# Growth in Transportation GHGs by Source, 1990-2004



# Passenger Vehicle GHGs, 1990-2004

GHGs increased  
23 percent 1990-2004

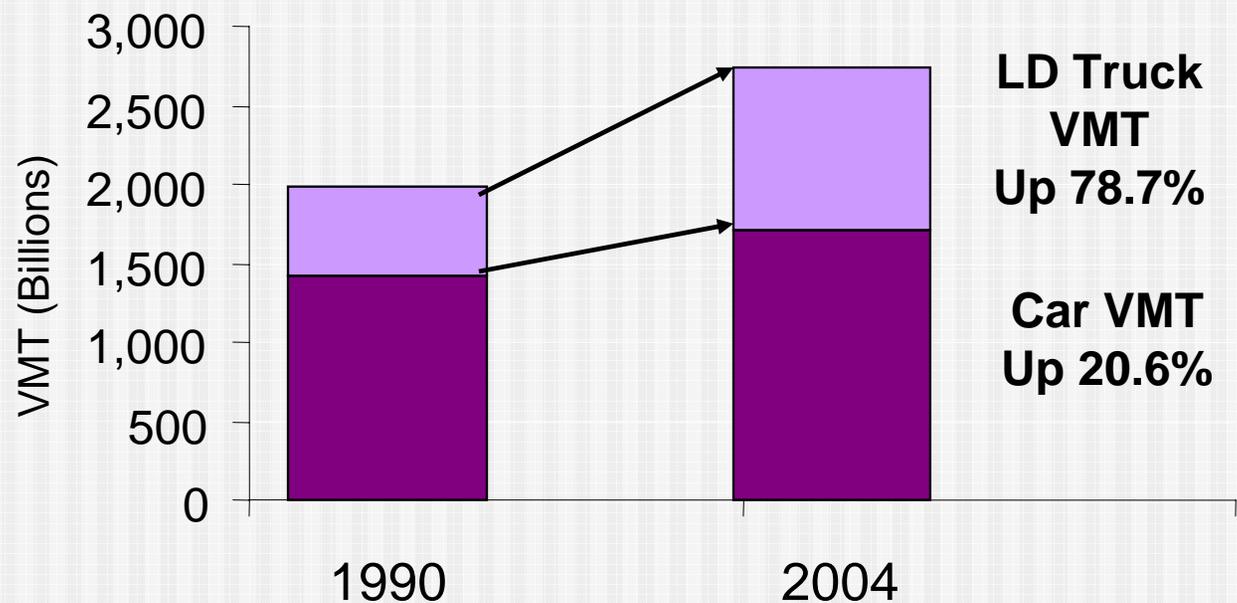
- Passenger Car GHGs  
up 1.8 percent
- Light-Duty Truck GHGs  
up 64.1 percent



# Passenger Vehicle GHGs – VMT trends

VMT increased 37  
percent 1990-2004

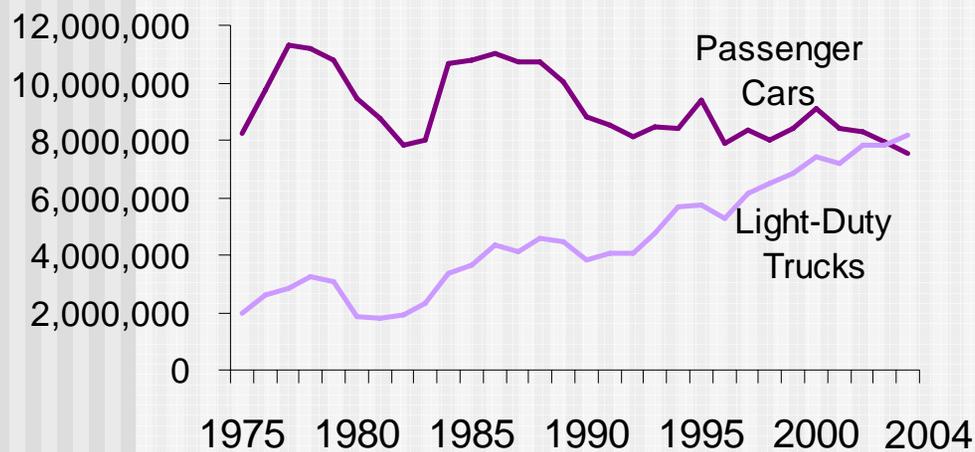
- Passenger Car VMT  
up 20.6 percent
- Light-Duty Truck VMT  
up 78.7 percent



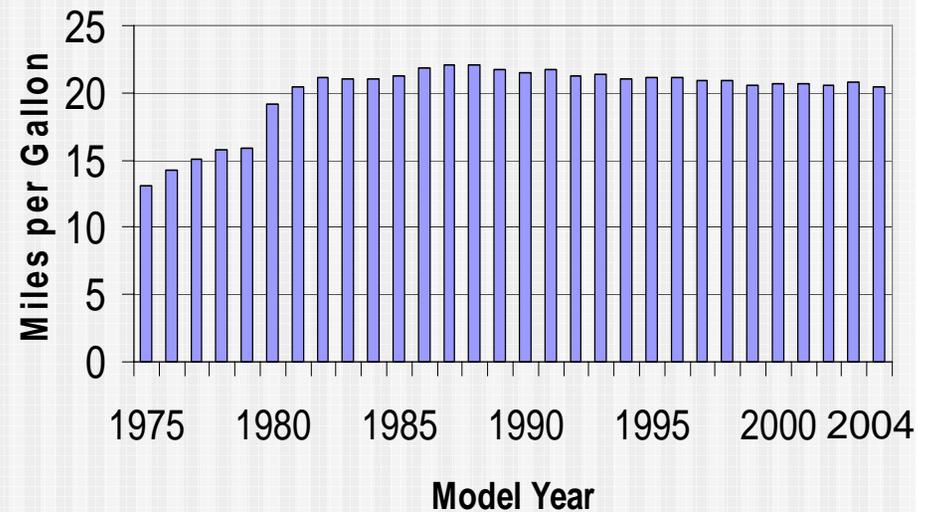
Source: FHWA Highway Statistics 2004

# Passenger Vehicle GHGs – Changing Vehicle Fleet Mix

Sales of New Cars and  
Light-Duty Trucks, 1975-2004



Sales-Weighted Fuel Economy of New  
Cars and Light-Duty Trucks, 1975-2004

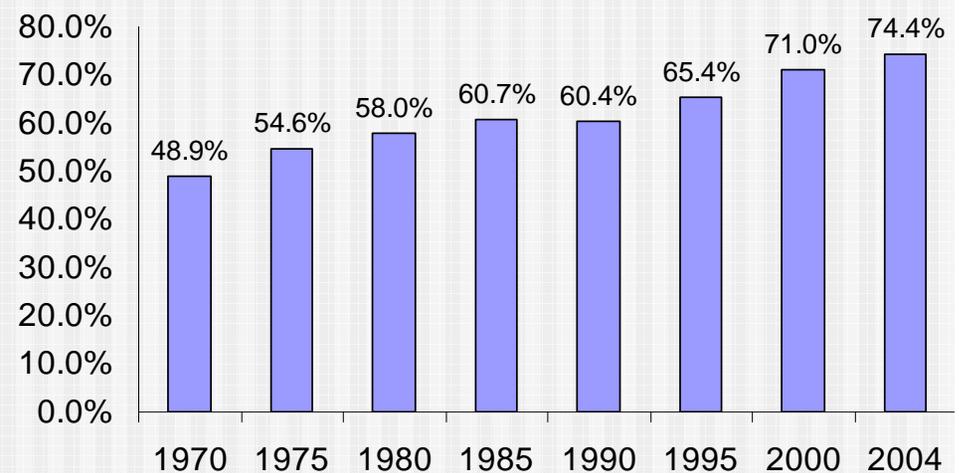


Source: EPA, *Light-duty Automotive Technology and Fuel Economy Trends: 1975 through 2005, July 2005.*

# Commercial Aircraft GHGs

- GHGs increased 10 percent 1990-2004
- Passenger miles traveled increased 64 percent
- Increased passenger loads
- Increased energy efficiency of new aircraft (~2 percent improvement annually)
- GHGs per passenger mile decreased 33 percent

**Percentage of Seats Occupied, 1970-2004**

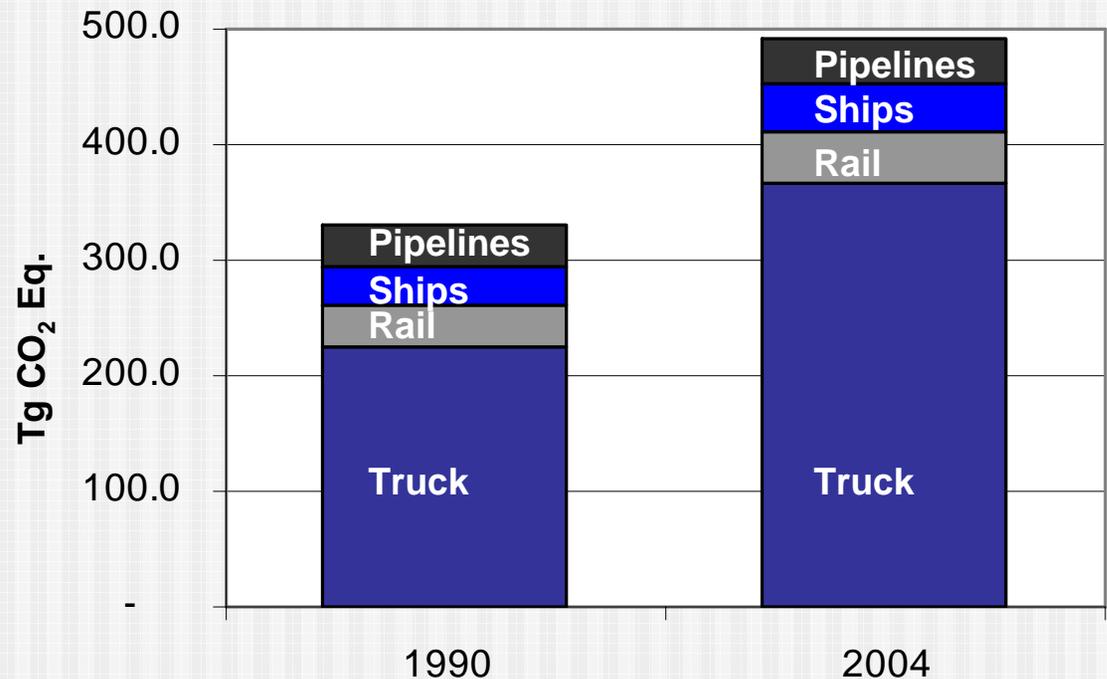


*Source: National Transportation Statistics 2005*

# Medium- and Heavy-Duty Truck GHGs

- GHGs increased 62 percent
- VMT increased by 53 percent
- Rapidly increasing share of overall freight GHGs

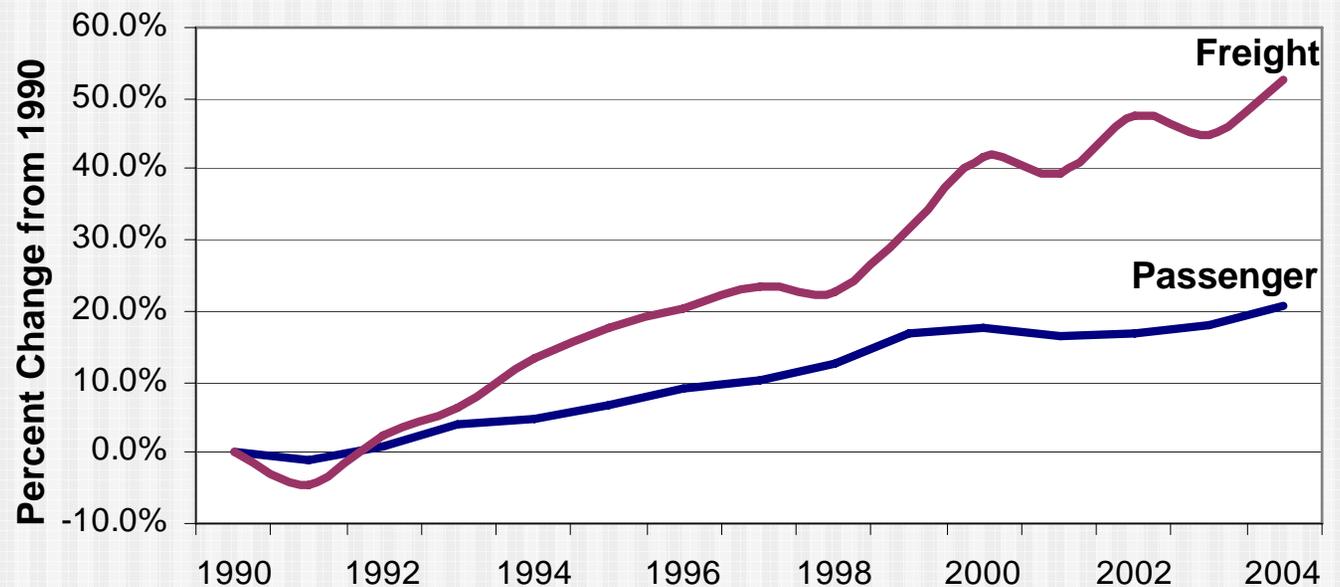
Freight GHGs by Source, 1990 and 2004



# Growth in Passenger and Freight GHGs, 1990-2004

**Freight  
Transportation  
GHGs increased  
52.6 percent**

**Passenger  
Transportation  
GHGs increased  
20.6 percent**



# Estimating CO<sub>2</sub>: Traditional inventory Approach and Related Uncertainty

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- Have traditionally used EIA's "top-down" estimates of fuel consumption by economic sector
- Multiply by carbon content of fuel and adjusting for carbon that does not oxidize during combustion (UNFCCC values)
- OTAQ allocates CO<sub>2</sub> to specific modes using "bottom-up" fuel consumption and activity
  - FHWA *Highway Statistics*
  - Oak Ridge National Laboratories *Transportation Energy Data Book*
- Inconsistencies between the top-down and bottom-up data

# Comparison of EIA Fuel Consumption Estimates with Bottom-Up Data (2003)

Fuel Type/Vehicle Type	2003 Inventory Est.	2003 Bottom-Up Est.	Difference	Percent Difference
<b>Gasoline</b>	<b>1,143.70</b>	<b>1,153.90</b>	<b>10.2</b>	<b>0.89%</b>
Automobiles	630.2	635.8	5.6	0.89%
Light-Duty Trucks	460.9	465	4.1	0.89%
Heavy-Duty Trucks	39.6	39.9	0.3	0.76%
Buses	0.3	0.3	0	0
Motorcycles	1.6	1.6	0	0
Boats (Recreational)	11	11.1	0.1	0.91%
<b>Diesel Fuel</b>	<b>386.6</b>	<b>417</b>	<b>30.4</b>	<b>7.86%</b>
Automobiles	3.4	3.7	0.3	8.82%
Light-Duty Trucks	17.6	19	1.4	7.95%
Heavy-Duty Trucks	301.1	325.5	24.4	8.10%
Buses	8	8.6	0.6	7.50%
Locomotives	39.6	42.8	3.2	8.08%
Ships and Boats	17	17.4	0.4	2.35%
<b>Electricity</b>	<b>3.2</b>	<b>3.9</b>	<b>0.7</b>	<b>21.88%</b>
<b>Jet Fuel</b>	<b>169</b>	<b>152.7</b>	<b>-16.3</b>	<b>-9.64%</b>
Commercial Aircraft	122.8	122.8	0	0
Military Aircraft	20.5	20.5	0	0
General Aviation Aircraft	9.4	9.4	0	0
Other Aircraft	16.3	-		

# Comparison of EIA Fuel Consumption Estimates with Bottom-Up Data

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- **Interagency Discussions with EIA and FHWA**
- **Determined that EIA was using older FHWA data in its fuel consumption estimates**
- **Recognized that EPA should calculate CO<sub>2</sub> using best available data sources, which include bottom-up data**

# Improvements in the 2006 *Inventory*

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- **Implemented bottom-up calculation of transportation diesel**
  - Held constant EIA estimate of total diesel consumption across all sectors
  - Non-transportations sectors adjusted downward
- **Use of an updated oxidation fraction estimate**
  - 2004 EPA study indicated that light-duty gasoline vehicles combust 100 percent of fuel (default assumption was 99 percent)
  - Study was reviewed and incorporated into IPCC reporting guidelines

# Forthcoming Improvements in the 2007 *Inventory*

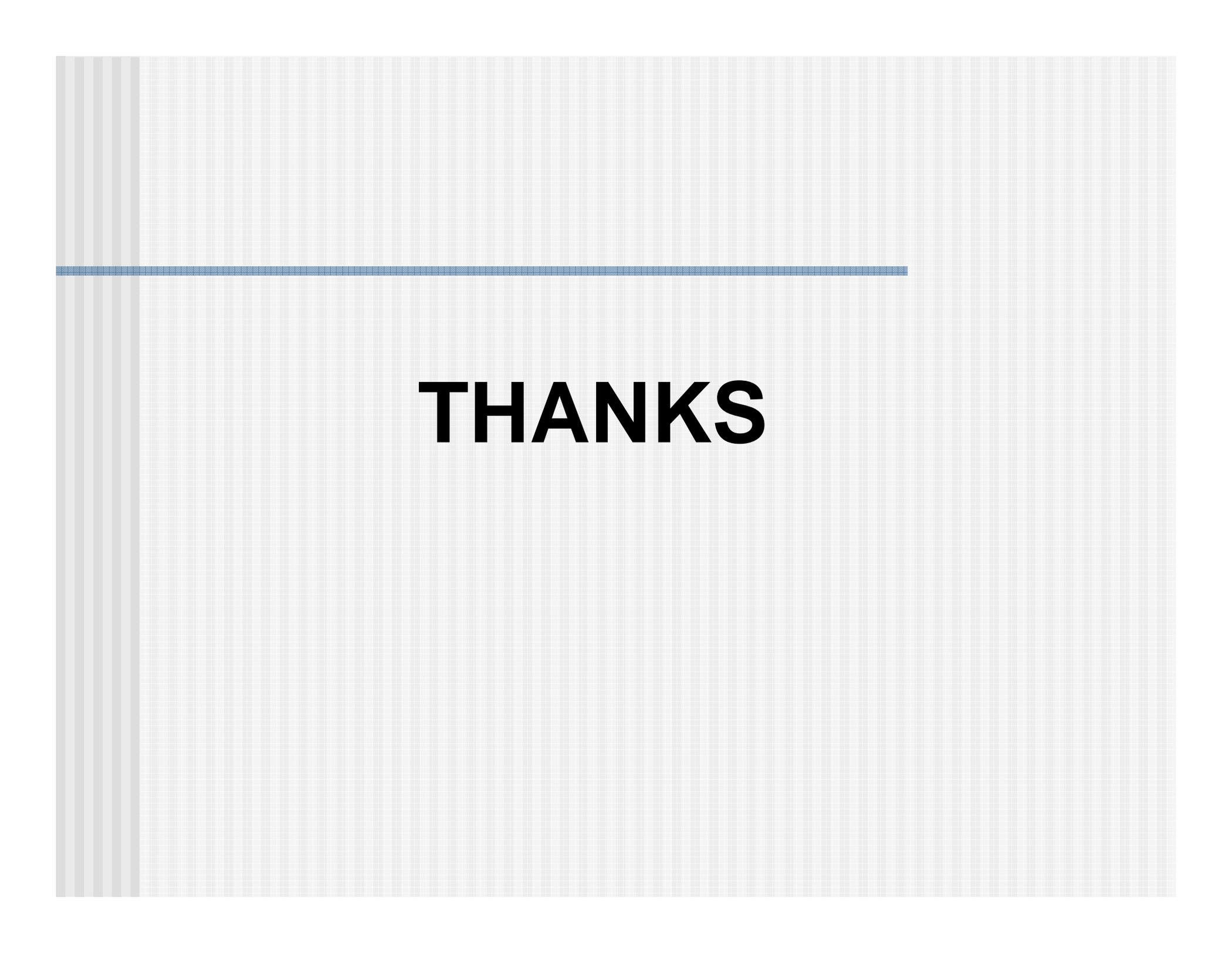
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- **Developed new Tier 2 Emissions Factors to inform estimates of light-duty CH<sub>4</sub> and N<sub>2</sub>O**
- **Used FAA SAGE data to estimate aviation fuel consumption**
- **EPA's updated Nonroad model used for non-highway mobile calculations**

# Planned Improvements for future *Inventory* estimates

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- **Continue reconciling bottom-up and top-down data used to estimate CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O**
- **Improve estimation of VMT and fuel consumption by vehicle type**
- **Improve consideration of off-road vehicle use**
- **Integration of estimates with EPA's MOVES model**



**THANKS**