



STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECTION

**2018 Statewide Greenhouse Gas
Emissions Inventory**

October 2019

Executive Summary

The Statewide Greenhouse Gas (GHG) Emissions Inventory (Sources and Sinks) has been updated to cover the years 2016 to 2018. The total gross GHG emissions in 2018 reached 105.1 million metric tons CO₂e. It is estimated that the State's land sector (forests and associated land cover) sequestered the equivalent of 8.1 million metric tons CO₂ resulting in net GHG emissions of 97.0 million metric tons CO₂e for 2018.

The bulk of the 2018 GHG emissions were energy related, comprising 86% of the total gross emissions. The remaining emissions (14%) were from non-energy sectors, most of which consisted of non-CO₂ greenhouse gases: methane, nitrous oxide and the highly warming halogenated/fluorinated gases.

Energy emissions came from the major economic sectors: transportation, electric power generation, commercial & industrial, and residential sectors. The transportation sector remains as the largest source of GHG emissions in the State with 40.6 million metric tons CO₂e in 2018. The electricity generation sector now accounts for 18.1 million metric tons CO₂e, still a substantial portion of the inventory. Close behind are the combined commercial & industrial sectors with 16.6 million metric tons CO₂e and the residential sector with 15.2 million metric tons CO₂e.

Non-energy emission contributions were mainly from the sectors & activities that generate and/or use highly warming gases such as agriculture (animal and soil management), electric and natural gas transmission and distribution infrastructure, and the variety of end-uses of halogenated/fluorinated gases (8.0 million metric tons CO₂e). The waste management sector comprised of solid waste landfills and waste water treatment facilities account for 5.3 million metric tons CO₂e. Land clearing contributed 1.0 million metric tons CO₂ as a result of lost carbon in biomass and soil removed or disturbed.

In this latest inventory update report, new emission estimate methods were employed to the gasoline and distillate land transportation sub-sectors and the halogenated gases sub-sector. The transportation emissions were estimated utilizing the U.S. Environmental Protection (USEPA) Motor Vehicle Emissions Simulator (MOVES) model. Highly warming gas emissions were estimated utilizing the U.S. Climate Alliance (USCA) methodology. Both methodologies more accurately account for state emissions. As a result of these changes, the 2006 baseline emissions used to determine the 2050 goals were also adjusted downward resulting in a slightly lower 2050 goal of 24.1 million metric tons CO₂e.

Background

This report presents New Jersey's Statewide greenhouse gas (GHG) Emissions Inventory updated estimates for the years 2016, 2017 and 2018, highlighting key aspects of the State's GHG emissions profile. Periodic inventory updates provide vital information for assessing the State's progress towards meeting the GHG emission limits set by the New Jersey's Global Warming Response Act (GWRA) for the years 2020 and 2050.

The GWRA requires the Department of Environmental Protection (DEP) to establish an inventory of current and 2006 Statewide GHG emissions and an inventory of the 1990 level of State GHG emissions. To that end, the initial GHG inventory for the State, published in November 2008¹ estimated the State's 1990 emissions, establishing the baseline for the 2020 limit; estimated emissions for 2004, and projected emission through 2020 (including 2006, which is the established baseline for the 2050 limit). The GWRA further requires the DEP to biennially update the Statewide GHG inventory. The DEP released inventory updates in November 2009 (presenting 2005 – 2007 data), May 2011 (presenting 2008 data), November 2012 (presenting 2009 data), September 2015 (presenting 2010, 2011 and 2012 data), and December 2017 (presenting 2013, 2014, and 2015 data). This 2018 inventory report constitutes the latest update.²

Data and Methods

As in previous statewide inventories, the 2018 inventory update is primarily based on emissions data from the DEP's emission statement database³ and on fuel use data from the Energy Information Administration (EIA) of the U.S. Department of Energy.^{4,5} Methods used to derive the emissions estimates from the data are detailed in the report "New Jersey Greenhouse Gas Inventory and Reference Case Projections 1990 – 2020" (Inventory and Projections), published November 2008. Any modifications or refinements in methodologies from the November 2008 document are described in the appendices to each of the subsequent updates mentioned above. The modifications or refinements in methodology for this inventory update are discussed in the appendix to this report (Appendix A). A major change was in the application of the U.S. Environmental Protection Agency (USEPA) Motor Vehicle Emissions Simulator (MOVES) model for estimating emissions from the on-road gasoline and diesel (distillate) sub-sectors of the Transportation sector. MOVES estimates emissions via vehicle miles traveled (VMT) in New

¹ New Jersey Greenhouse Gas Inventory and Reference Case Projections 1990 – 2020, *New Jersey Department of Environmental Protection*, November 2008.

² Inventories are subject to availability of information from the United States Energy Information Administration (EIA), which has a lag time of 2 years for collection and publication of data.

³ NJDEP, *Bureau of Stationary Sources/Division of Air Quality*

⁴ <http://www.eia.doe.gov/oiaf/1605/coefficients.html> (accessed, April 12, 2019)

⁵ <http://www.eia.gov/state/seds> (accessed, May 10, 2019)

Jersey whereas previous estimates were based on retail fuel sales. Another change was the use of the US Climate Alliance tool to estimate highly warming gases.

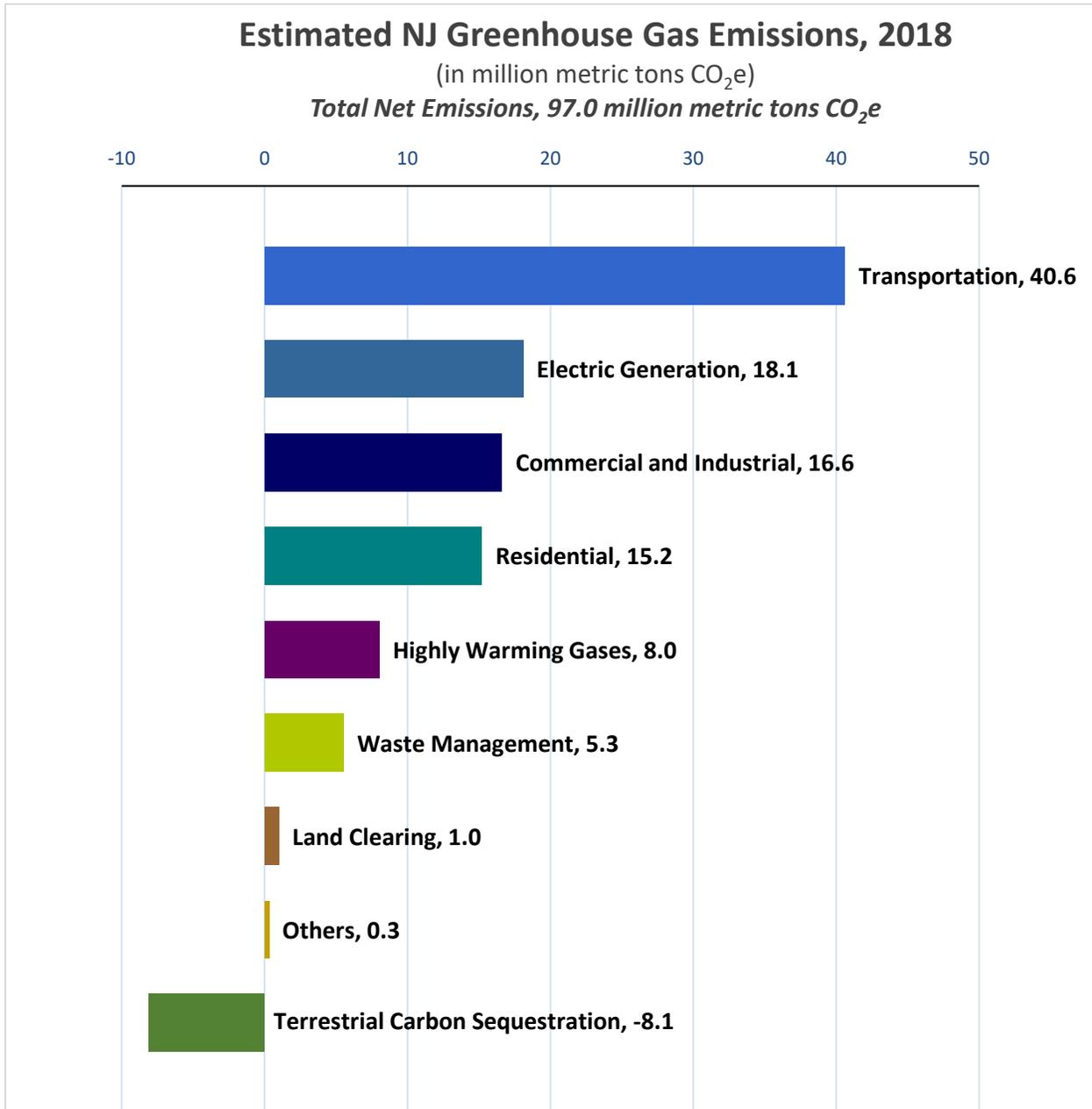
New Jersey GHG Emissions for 2016, 2017, and 2018

Estimated net greenhouse gas emissions⁶ are as follows: **103.3** million metric tons of carbon dioxide equivalent (*MMTCO₂e*) in 2016; **97.0** *MMTCO₂e* in 2017; **97.0** *MMTCO₂e* in 2018.⁷ The sectoral distribution of the greenhouse gas emissions for 2018 is shown in Fig. 1 below.

⁶ **Net GHG emissions** is the difference between the addition of greenhouse gases into the atmosphere through *emissions*, primarily carbon dioxide, and the removal of carbon from the atmosphere through *sequestration* via plant growth and land use (acting as natural carbon sinks). **Gross emissions** represent the total of all emissions, including carbon release from land clearing.

⁷ “Carbon dioxide equivalent” represents the conversion of all emitted compounds, which include methane and other gases, to the equivalent quantity of carbon dioxide using global warming potentials (GWP), as discussed in the periodic reports of the Intergovernmental Panel on Climate Change (IPCC). See IPCC AR5, 2013, Climate Change 2013: Working Group I: The Physical Science Basis www.ipcc.ch/report/ar5/wg1/ (accessed 5/15/2019).

Figure 1



As with previous inventory years, the four leading sectors of GHG emissions in 2018, are transportation, electricity generation, residential, and commercial & industrial fossil fuel use. Specifically, transportation remains as the largest source of GHG emissions at 40.6 MMTCO₂e, or 42% of the net statewide emissions. The electricity generation sector's contribution to New Jersey's inventory has increased since 2015, now accounting for 18.1 MMTCO₂e, or 19% of net statewide emissions; as has the combined contribution of the commercial and industrial sectors to 16.6 MMTCO₂e, or 17% of the net emissions. The residential sector emissions reached 15.2 MMTCO₂e, 16% of the net statewide total. Carbon captured by the state's natural sinks

(growth of forests and other vegetation plus soils left undisturbed) still remains at 8.1 MMTCO_{2e} in 2018, “offsetting” 8% of the gross statewide GHG emissions.

Table 1 presents the 2016-2018 emissions by category, as well as the 1990 and 2006 baseline emissions for comparison. Appendix B provides a detailed sub-sector breakdown of the data estimates.

Table 1

Estimated 2016-2018 New Jersey Greenhouse Gas (GHG) Emissions					
<i>million metric tons CO_{2eq}</i>					
<i>(MMTCO_{2eq})</i>					
<u>Sector</u>	<u>2006</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	
<i>Energy</i>					
Transportation	43.9	42.8	42.4	40.6	
Electricity Generation	31.0	21.4	18.0	18.1	
Commercial and Industrial	25.5	18.4	15.8	16.6	
Residential	13.7	14.6	14.5	15.2	
<i>Non-Energy</i>					
Highly Warming Gases*	5.7	7.6	7.8	8.0	
Waste Management**	4.9	5.3	5.3	5.3	
Land Clearing	1.8	1.0	1.0	1.0	
Others	0.1	0.3	0.3	0.3	
Total Emissions	126.6	111.4	105.1	105.1	
Terrestrial Carbon Sequestration	-6.0	-8.1	-8.1	-8.1	
Total Net Emissions	120.6	103.3	97.0	97.0	

**includes halogenated gases, sulfur hexafluoride, agriculture, natural gas transmission and distribution*

***includes solid waste in-state landfills, industrial landfills and out-of-state disposal as well as waste water treatment*

Analysis of the 2018 Update Results

This section contains a brief analysis of the updated inventory information shown in Table 1, identifying trends and highlighting data for certain sectors. This analysis also discusses implications for the GWRA 2020 and 2050 statewide greenhouse gas limits.

New Jersey's Greenhouse Gas Emissions Profile Relative to GWRA Targets

The DEP's first GHG inventory established the 1990 statewide GHG emissions estimate at 125.6 MMTCO₂e – which equates to the GWRA 2020 limit. The State met that limit in 2008, and this inventory update shows that the 2018 emissions (97.0 MMTCO₂e) remained under the 2020 target limit. For the year 2050, the GWRA GHG limit is an 80% reduction from the net GHG emissions in 2006 (120.6 MMTCO₂e), which equates to 24.1 MMTCO₂e. For 2018, net statewide GHG emissions were 97.0 MMTCO₂e.

The bulk of the 2018 GHG emissions are energy-related, constituting 86% of the total. Energy-related emissions emanate from the transportation, electricity generation, commercial & industrial, and residential sectors. The non-energy sources are sectors & activities producing and/or using highly warming gases (including agriculture, electric and natural gas transmission & distribution); the waste management sector (solid waste and waste water treatment); and land clearing. Non-energy emissions, when accounting for their higher global warming potentials (GWP), contributed 14% of the total.

National and Global GHG Emission Trends

To provide a context for the New Jersey statewide GHG emissions, this section provides a brief examination of recent U.S. and worldwide trends.

Energy-related CO₂ emissions in the U.S. rose in 2018 after three years of continuous decline⁸. Driving this trend are the emissions in the transportation and industrial sectors, increasing in 2017 and accelerating in 2018 based on stronger growth of the economy. However, the substantial change year-to-year was in the buildings and electricity sectors. The increase in buildings sector emissions was mainly due to a reversion to historical average winter weather after an unusually warm 2017. Energy-related CO₂ emissions account for 86% of all GHG in the U.S. It is estimated that the U.S. economy-wide emissions increased by 1.5% to 2.5% in 2018. Table 2 below shows the comparison of state, national, and global gross GHG emissions (2016-2018).

⁸ <https://rhg.com/research/final-us-emissions-estimates-for-2018/> (accessed 5/6/2019)

Table 2

Gross Emissions (million metric tons CO ₂ e)			
Year	New Jersey	U.S.	Global
2016	111.4	6,492	35,620
2017	105.1	6,457	36,200
2018	105.1	6,618*	37,100*

*Projected

Source: U.S. Environmental Protection Agency (USEPA) for national emissions; Rhodium Group for 2018 national emissions projection; and Global Carbon Project (GCP) for global emissions.

At the global level, the Global Carbon Project (GCP) reported that total CO₂ emissions from fossil fuels and industry rose by 1.6 % in 2017 to 36.2 billion metric tons CO₂. This number is projected to have climbed to a record 37.1 billion metric tons CO₂ in 2018⁹. CO₂ emissions from fossil fuel sources have grown by 2.7 % since last year, growing even more quickly than the previous year, which saw a 1.6 % increase. The GCP expects even further increases in 2019 given the persistent growth in oil and natural gas production and projected economic growth this year. The International Energy Agency (IEA) *World Energy Outlook 2018* similarly reported that, after three flat years, global energy-related CO₂ emissions rose by 1.6% in 2017 and suggests continued growth in 2018, far from a trajectory consistent with climate goals.

Another recent report *Renewables 2019 Global Status Report*¹⁰ indicated that the year 2018 saw a relatively stable market for renewable energy technologies. A total of 181 gigawatts (GW) of renewable power was added bringing the total to 2,738 GW, a consistent pace compared to 2017. For four years in a row, additions of renewable power generation capacity outpaced net installations of fossil and nuclear power combined. About 100 GW of solar PV was installed accounting for 55% of renewable capacity additions followed by wind power (28%) and hydropower (11%). Overall renewable energy has grown to account for more than 33% of the world's total installed power generating capacity. The number of countries integrating high shares (more than 20% of electricity mixes) of variable renewable energy is increasing (top three countries are Denmark, Uruguay, and Ireland; the U.S. had 18% and NJ 5.5% renewables in 2018). As of 2017, renewable energy accounted for 18% of total final energy consumption. Modern renewables supplied 10.6%, with an estimated 4.4% growth in demand compared to 2016. By the end of 2018, renewables provided more than 26% of global electricity generation. The transportation sector renewables increased slightly from the previous year to reach 3.3%.

⁹ R B Jackson *et al* 2018 Global energy growth is outpacing decarbonization. *Environmental Research Letters* published December 5, 2018.

¹⁰ Published by the Renewable Energy Network 21 (REN21), a consortium of organizations, institutions and governments.

The bulk of this is provided by liquid biofuels. However, there is opportunity to increase the renewable share in the transportation sector through expansion of renewable electric generation. The deployment of electric vehicles (EVs) on the world’s roads increased in 2018. The number of electric passenger cars (5.1 million) increased 63% compared with 2017, and more cities are moving to electric bus fleets.

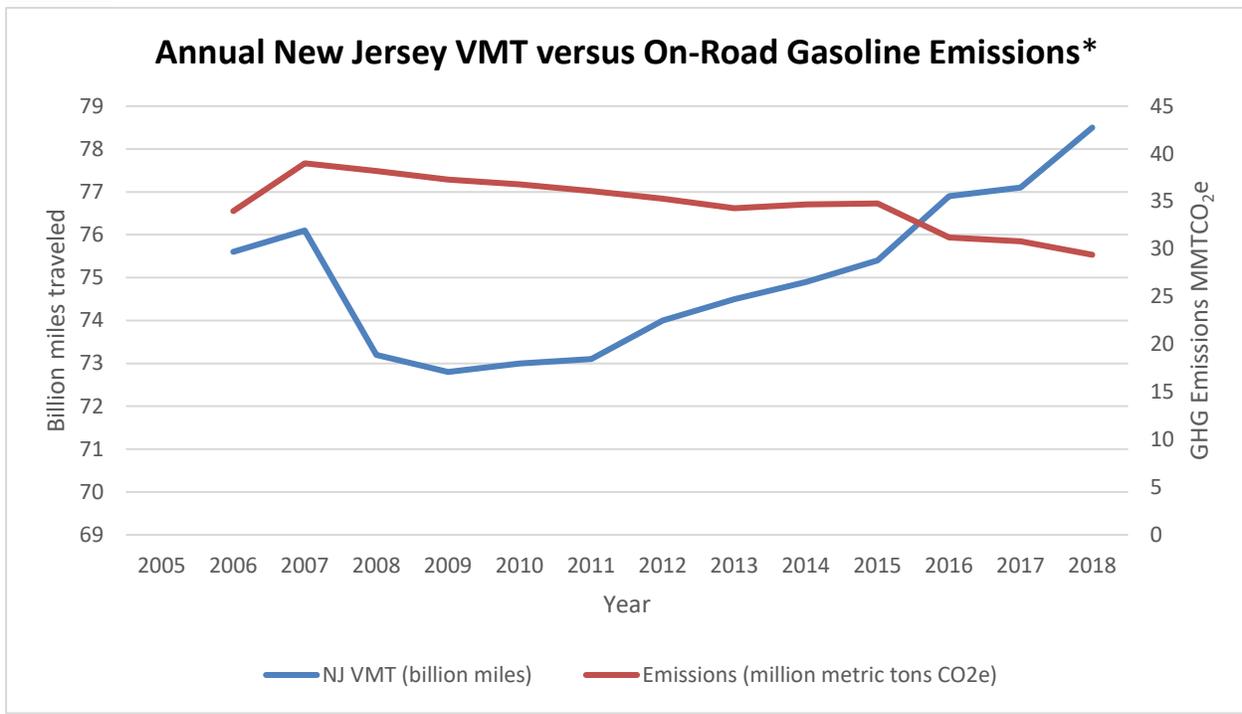
The REN21 report concludes that renewable energy has established itself on a global scale. In 2018, more than 90 countries had installed at least 1 GW of generating capacity, while at least 30 countries exceeded 10 GW of capacity.

STATE ENERGY-RELATED EMISSIONS

Transportation

The transportation sector remains as the largest contributor to statewide GHG emissions. Transportation emissions amounted to 40.6 MMTCO₂e in 2018. Within this sector, there were slight reductions in certain sub-sectors, particularly in on-road gasoline and on-road diesel, from 2016 to 2018. As shown in Figure 2, these reductions occurred against the background of continuing growth in vehicle miles traveled (VMT) since the economic recovery in 2010 (VMT declined during the 2008-2009 economic recession).

Figure 2



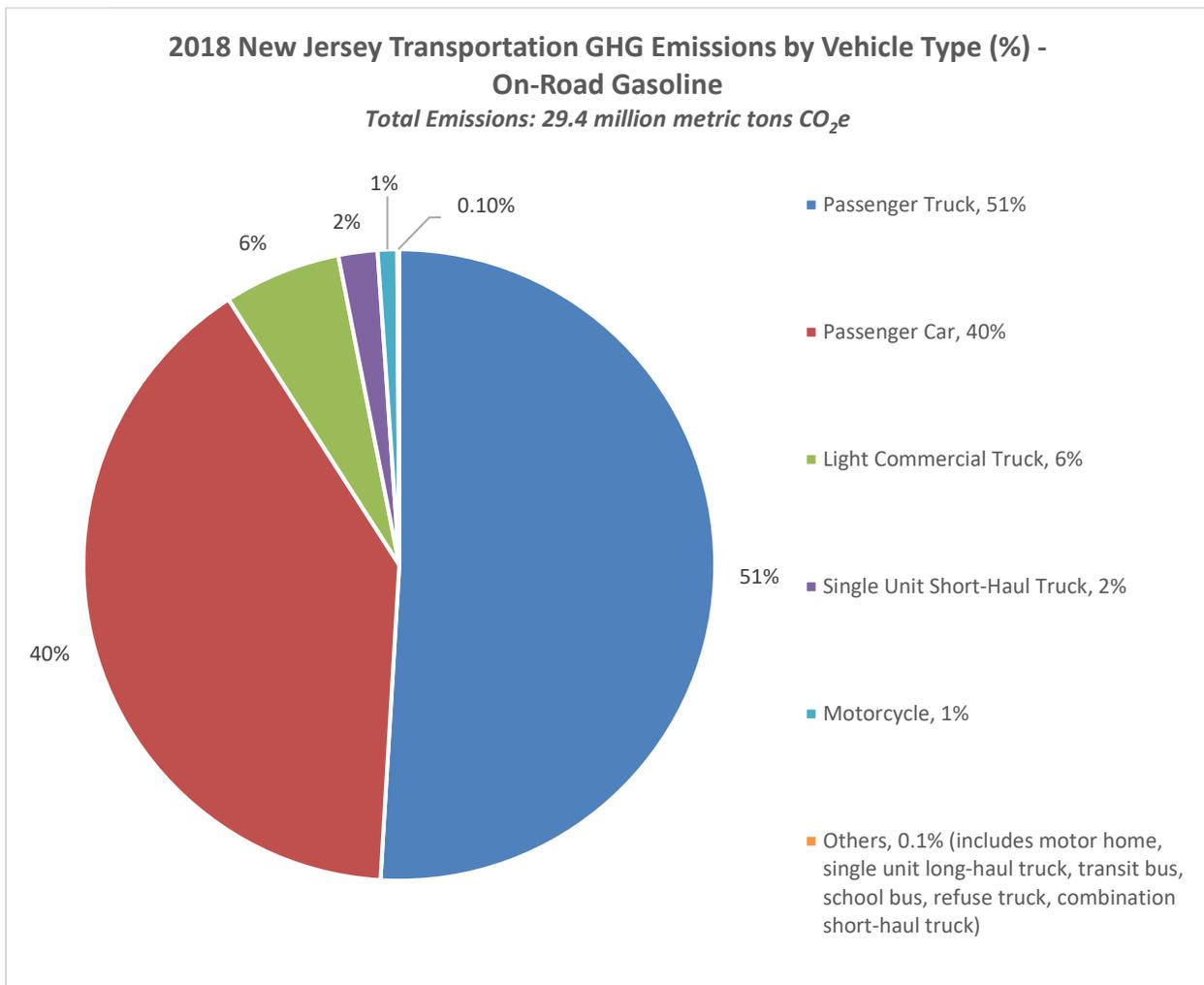
*Emissions estimates for 2006, 2016, 2017 and 2018 reflect MOVES results.

Source: NJ Department of Transportation/Bureau of Transportation Data and Safety (VMT data)

Vehicle use is an indirect indicator of vehicle emissions and VMT is an indicator of vehicle use, accounting for the total miles traveled on roads and highways by motor vehicles in the state. It is estimated that in 2018, about 215 million miles were traveled per day on the state’s roadways, up 2.4% from 2016’s approximately 210 million miles per day.

In 2018, the top three GHG emitting (on-road gasoline) vehicle types were passenger trucks, passenger cars, and light commercial trucks. These types accounted for 97% of the emissions and 99% of miles traveled (VMT) in the on-road gasoline sub-sector last year. Figure 3 indicates the percentage of on-road gasoline emissions for each vehicle type.

Figure 3

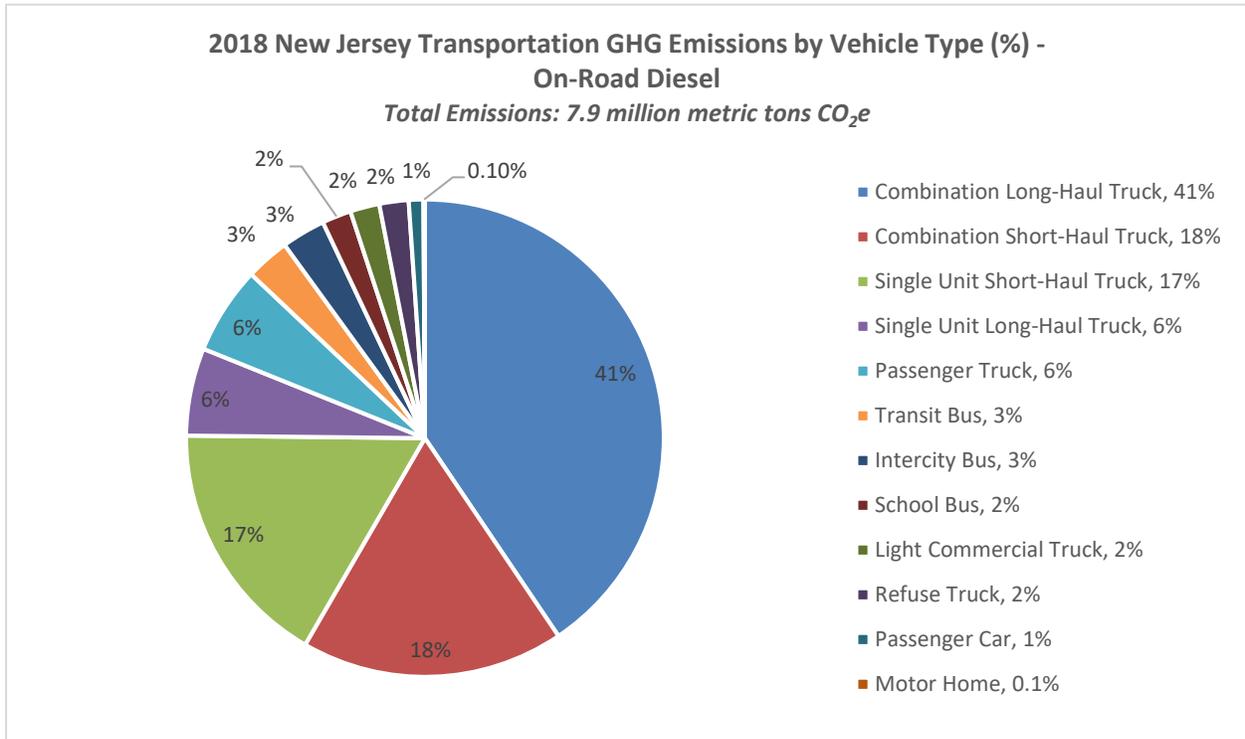


Source: NJDEP/Air Quality, Energy and Sustainability

For on-road diesel, the top three emitting vehicle types in 2018 were: combination long-haul trucks, combination short-haul trucks, and single unit short-haul trucks. Together, these three vehicle types accounted for 76% of the emissions and 62% of the miles traveled in the on-road

diesel sub-sector last year. Figure 4 shows the percentage of on-road diesel emissions for each vehicle type in 2018.

Figure 4



Source: NJDEP/Air Quality, Energy and Sustainability

The minimal reductions in GHG emissions despite VMT growth are likely attributed to increases in vehicle fuel efficiency of the U.S. vehicle population. Most of the light-duty vehicle types experienced significant fuel efficiency increases. Table 3 shows the relative vehicle fuel efficiency changes across types. The expectation of further emission reductions in this sector through increased vehicle fuel efficiency is currently threatened by a proposed rollback of federal mileage standards for motor vehicles (mpg).

Table 3

Average Fuel Efficiency of U.S. Passenger Cars and Light Trucks (miles per gallon)			
	<u>2006</u>	<u>2016</u>	<u>% change (2006-2016)</u>
Average U.S. Passenger Car	8.7	9.4	8%
Light Duty Vehicle (LDV), short wheel base	9.6	10.2	6%
LDV, long wheel base	7.6	7.4	-3%
<i>New Vehicle Fuel Efficiency</i>			
LDV			
Passenger Car	12.8	16.0	25%
>Domestic	12.9	15.9	23%
>Imported	12.6	16.2	29%
Light Trucks	9.5	11.6	22%

Source: U.S. Department of Transportation/Bureau of Transportation Statistics¹¹

Another path leading to a cleaner transportation sector is vehicle electrification. Although still modest, the State is making progress in this area. As of June 2019, there were 26,840 electric vehicles registered in New Jersey. This number is comprised of battery electric vehicles (BEV) and plug-in hybrid electric vehicles (PEV). Just a few years earlier, in 2012, there were only 338 electric vehicles registered in New Jersey, and now the number has increased nearly eighty-fold¹². Figure 5 below shows the State as 16th in the nation in terms of zero emission vehicles (ZEV) sales per capita¹³.

New Jersey has also made significant progress in developing the supporting infrastructure of electric vehicle charging stations. There are currently 878 publicly accessible charging outlets at 316 locations in New Jersey. In addition, the Federal Highway Administration has designated five NJ highways as “Electric Vehicle (EV) Corridors” where fast chargers allow worry-free electric travel. Those highways link up with EV Corridors in neighboring states and throughout the Northeast and Mid-Atlantic region. This, along with federal and state incentives already in place and decreasing battery costs, helps to sustain the momentum for growth in the number of electric vehicles used in New Jersey.

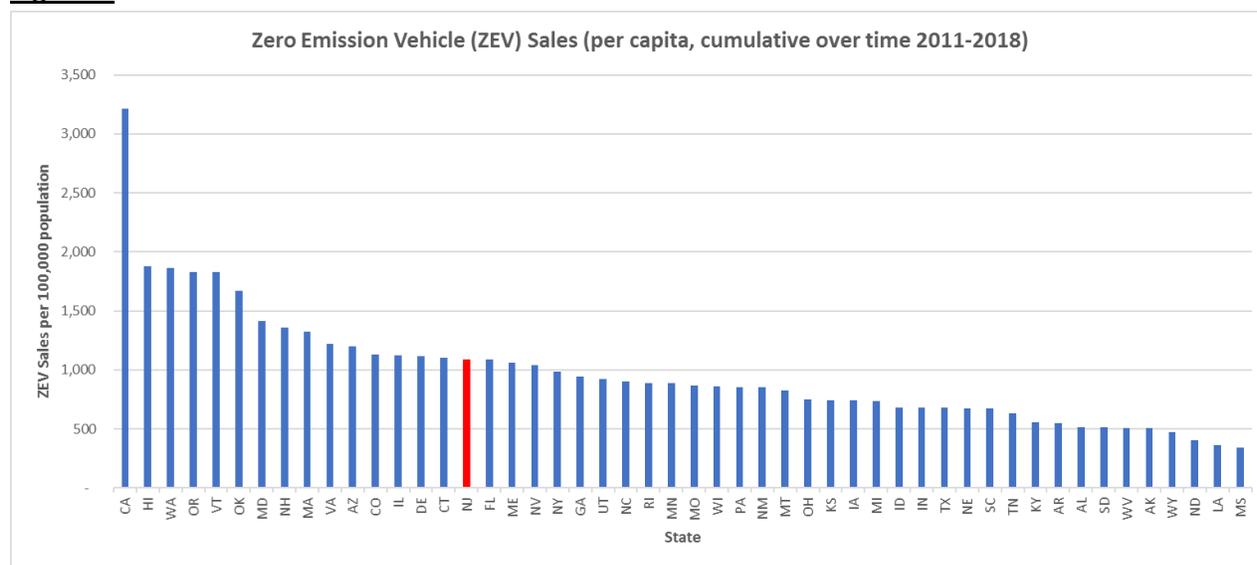
¹¹ <https://www.bts.gov/content/average-fuel-efficiency-us-passenger-cars-and-light-trucks> (accessed June 5, 2019)

¹² NJDEP, Bureau of Mobile Sources/Division of Air Quality

¹³ Alliance of Automobile Manufacturers. “Advanced Technology Vehicle Sales Dashboard.” August 2019. <https://autoalliance.org/energy-environment/advanced-technology-vehicle-sales-dashboard/>.

U.S. Census Bureau, “Annual Estimates of the Resident Population for the United States, Regions, States, and Puerto Rico.” August 2019, <https://www.census.gov/data/tables/time-series/demo/popest/2010s-national-total.html>

Figure 5



Source of Basic Data: *Auto Alliance, 2019*

Electricity Generation

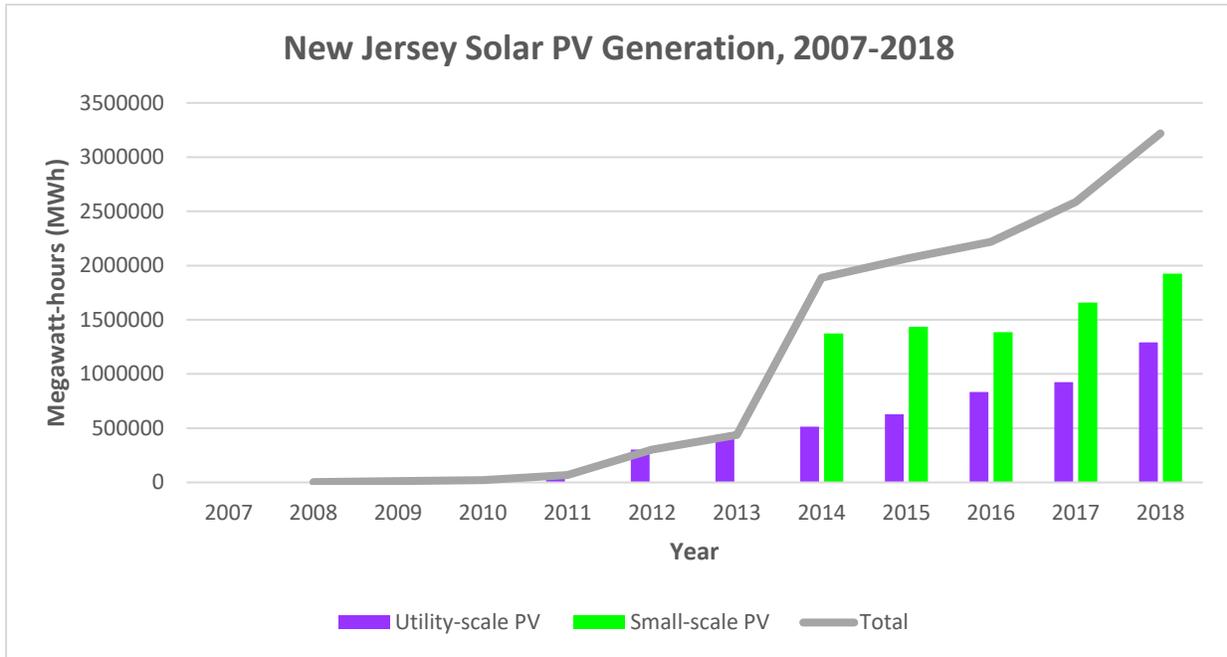
The electricity generation sector continued to contribute a comparatively smaller (relative to the transportation sector) and declining share of the overall gross GHG emissions, comprising 17% in 2018. Over a decade earlier, in 2006, this sector constituted 24% of the overall total.

The fuel mix of the sector since 2006 has dramatically changed. The dominant fossil fuel is now natural gas which, combined with nuclear energy, compose New Jersey's primary energy sources, accounting for over 90% of electricity generation. The share of coal continues to decline; while growth in renewables doubled since 2006. Renewables now comprise twice as much of New Jersey's energy mix as coal (even without counting the contribution of small-scale solar).

The contribution of solar PV to in-state electricity generation reached over 3 million megawatt-hours in 2018. The rapid growth of this renewable energy is depicted in Figure 6. Total solar PV generation (utility-scale and small-scale) grew by 70% in the short period from 2014 to 2018, a remarkable increase of 18% annually. This translates to almost 1.4 million metric tons of avoided CO₂ emissions in 2018. Figure 7 displays the increasing trend in avoided CO₂ emissions due to solar PV generation (both utility scale and total solar).

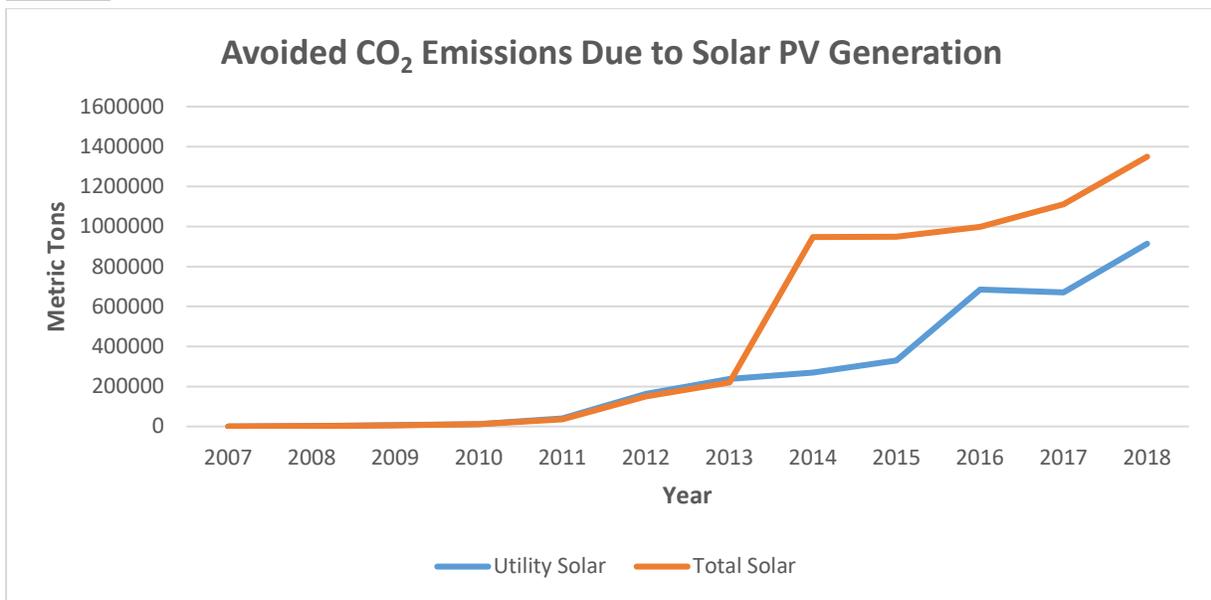
According to the U.S. Department of Energy/Energy Information Administration (EIA), New Jersey was the country's 5th largest producer of electricity from solar energy in 2017, and nearly 75% of the State's renewable electricity generation came from solar power.

Figure 6



Source: USDOE/EIA

Figure 7



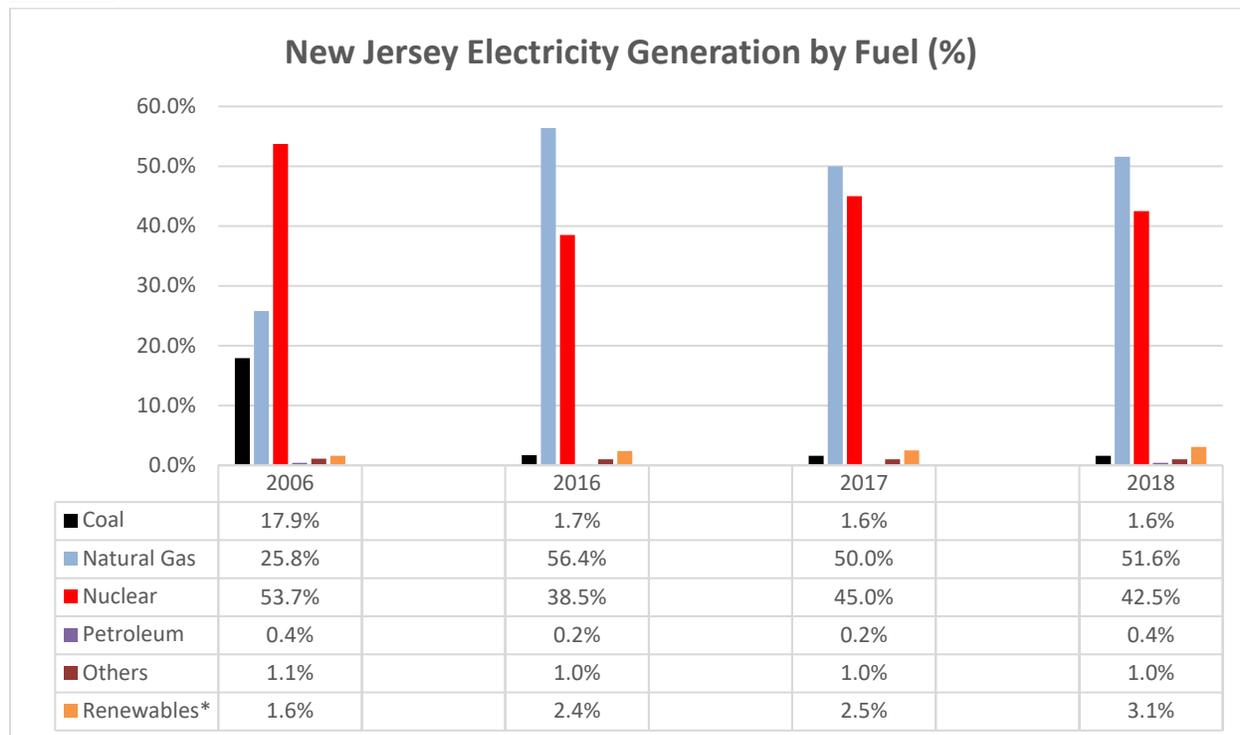
Source: EIA (Generation Data); U.S. Environmental Protection Agency and PJM (Factors for CO₂ Avoided Emissions calculations)

*EIA started accounting for small-scale solar PV generation in 2014.

The contribution of renewables in electric power generation is expected to continue increasing in the coming years as offshore wind energy starts to come online and energy storage allows for optimum integration of renewables in the electric grid. New Jersey's renewable portfolio standard (RPS) was updated in 2018 to require that 21% of the electricity sold in the State be

generated from renewable sources by 2021, 35% by 2025, and 50% by 2030. This is part of the State’s efforts to meet Governor Murphy’s commitment to 100% clean energy by 2050. Figure 8 below shows the fuel mix in the last three years compared to 2006.

Figure 8



*excluding small-scale solar Source: U.S. Department of Energy/Energy Information Administration

Residential

From 2016 to 2018, residential GHG emissions increased by 4 percent. According to EIA, about 75% of New Jersey households rely on natural gas as their primary heating fuel, 12% use electric heat, and 10% use heating oil. Weather factors may have also contributed to the increase in emissions in recent years. Table 4 below provides the cooling degree days¹⁴ (CDD) and heating degree days¹⁵ (HDD) for the relevant time period.

¹⁴ **Cooling Degree Day (CDD):** A measure of how warm a location is over a period of time relative to a base temperature, most commonly specified as 65 degrees Fahrenheit. The measure is computed for each day by subtracting the base temperature (65 degrees) from the average of the day's high and low temperatures, with negative values set equal to zero. Each day's cooling degree days are summed to create a cooling degree day measure for a specified reference period. Cooling degree days are used in energy analysis as an indicator of air conditioning energy requirements or use.

¹⁵ **Heating Degree Day (HDD):** A measure of how cold a location is over a period of time relative to a base temperature, most commonly specified as 65 degrees Fahrenheit. The measure is computed for each day by subtracting the average of the day's high and low temperatures from the base temperature (65 degrees), with negative values set equal to zero. Each day's heating degree days are summed to create a heating degree day measure for a specified reference period. Heating degree days are used in energy analysis as an indicator of space heating energy requirements or use.

Table 4

Time Period	Cooling Degree Day (CDD)	Time Period	Heating Degree Day (HDD)
2016	1,061	2015-2016	4,451
2017	834	2016-2017	4,687
2018	1,072	2017-2018	5,176

Source: New Jersey Office of State Climatologist

Commercial and Industrial

For the years 2016 to 2018, the commercial and industrial sectors' GHG emissions decreased by about 10%. This is primarily due to reduction in natural gas consumption in both sectors where that fuel constituted 25% to 28% of the energy used. This reduction could be attributed to both reduction in demand and energy efficiency improvements.

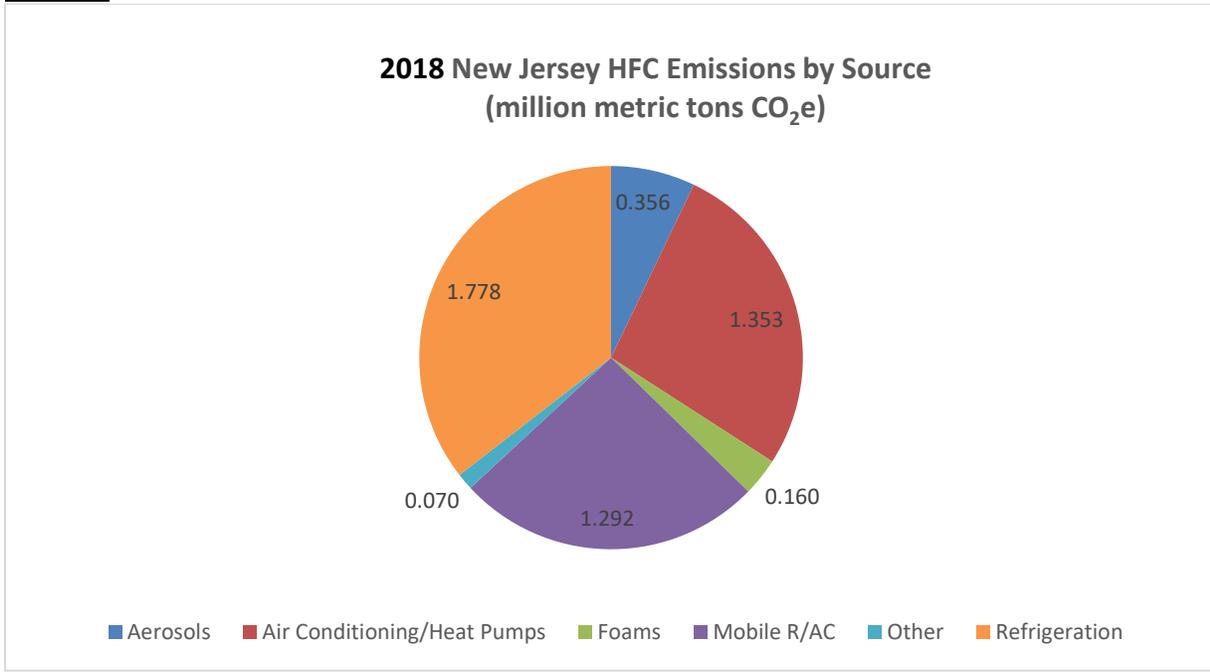
STATE NON-ENERGY EMISSIONS

Highly Warming Gases

The combined non-CO₂ GHG emissions from sectors using or producing halogenated gases; the electric transmission and distribution system (using sulfur hexafluoride as insulator); the natural gas transmission and distribution system; and agriculture (enteric fermentation, manure and soil management) increased by over 5% from 7.6 MMTCO₂e in 2016 to 8.0 MMTCO₂e in 2018. For emissions from halogenated gases, the U.S. Climate Alliance (USCA) tool, made available recently, was used to better account for state-specific characteristics (see Appendix B for details).

Hydrofluorocarbons (HFCs) has become the major substitute for ozone depleting substances (ODS) controlled by the Montreal Protocol. However, HFCs have high GWPs. Their use has become widespread across a variety of sectors, increasing their portion of New Jersey's overall GHG inventory. Figure 9 shows the 2018 estimated HFC emissions by end-use sector for New Jersey.

Figure 9



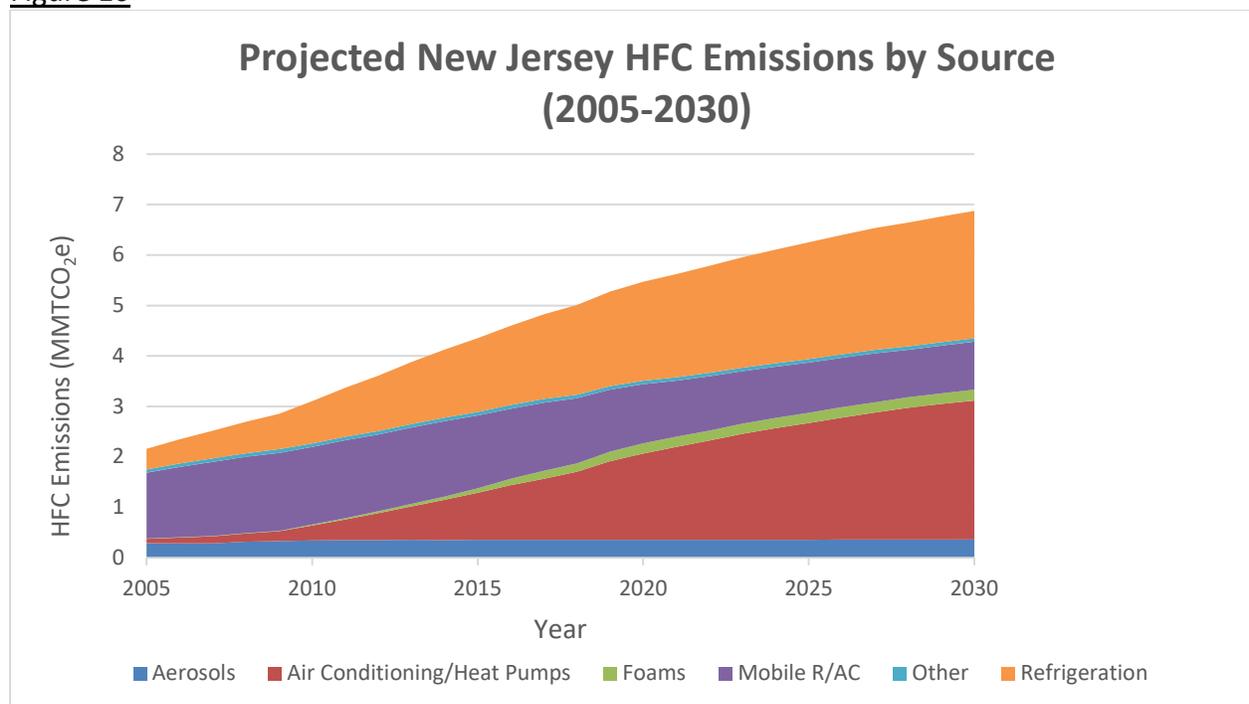
R- Refrigeration

AC- Air Conditioning/Heat Pumps

Source: U.S. Climate Alliance GHG Inventory Tool for Hydrofluorocarbons (HFC)

The increase in HFC emissions is driven by population growth and rising demand in the end-use sectors of refrigeration, air-conditioning, mobile refrigeration/air-conditioning, as well as heat pump applications. These emissions are projected to continue to grow in the coming years. Figure 10 shows projected HFC growth by source for the State.

Figure 10



R- Refrigeration

AC- Air Conditioning/Heat Pumps

Source: U.S. Climate Alliance GHG Inventory Tool for Hydrofluorocarbons (HFC)

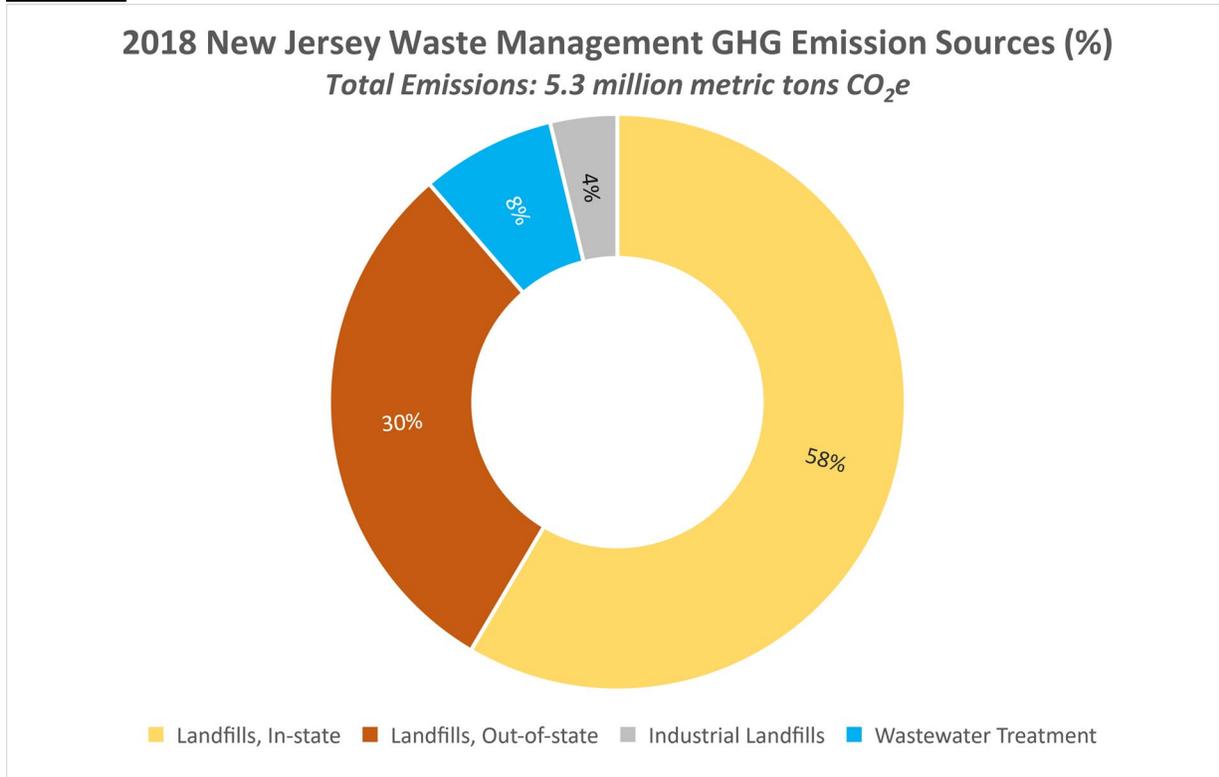
Waste Management

Waste management is major source of methane (CH₄), which also has a high GWP (25 times that of CO₂ over a 100-year time horizon)¹⁶ and is shorter lived than CO₂ in the atmosphere. Waste management was the largest source of non-energy GHG emissions in both 2006 and 2018. In 2018, GHG emissions from waste management was over 5 million metric tons CO₂e.

The 2018 percentages of waste management emissions by source are shown in Figure 11 below. In-state landfills accounted for the largest share of total waste management emissions (58%). A substantial portion is attributed to waste sent out of state (30%). Wastewater treatment contributed a small but still significant fraction of the total emissions from waste management (8%). The remainder of the emissions came from industrial landfills (estimated at 4%).

¹⁶ IPCC, AR4 (Fourth Assessment Report) https://www.ipcc.ch/site/assets/uploads/2018/05/ar4_wg1_full_report-1.pdf. While the IPCC Fifth Assessment Report has slightly higher GWP for CH₄, the USEPA still uses the AR4 value for its national GHG Inventory. Likewise, this inventory uses the same value.

Figure 11



Source of Basic Data: NJDEP/Solid and Hazardous Waste (for Solid Waste); USEPA (for Wastewater Treatment)

Land Clearing

It is well documented that converting land from its natural uses to a developed or disturbed condition causes significant, direct, as well as secondary and cumulative, environmental impacts. Negative impacts of land use change also lead to air pollution and loss of sequestered carbon in the soil and biomass. The loss of vegetation or biomass through land clearing contributes to global warming as it reverses the direct removal of CO₂ from the atmosphere by plant photosynthesis. Globally, deforestation contributes about 25% to global warming. In 2018, land clearing in New Jersey accounted for 1.0 MMT CO₂e of the total 105.1 MMT CO₂e statewide gross emissions.

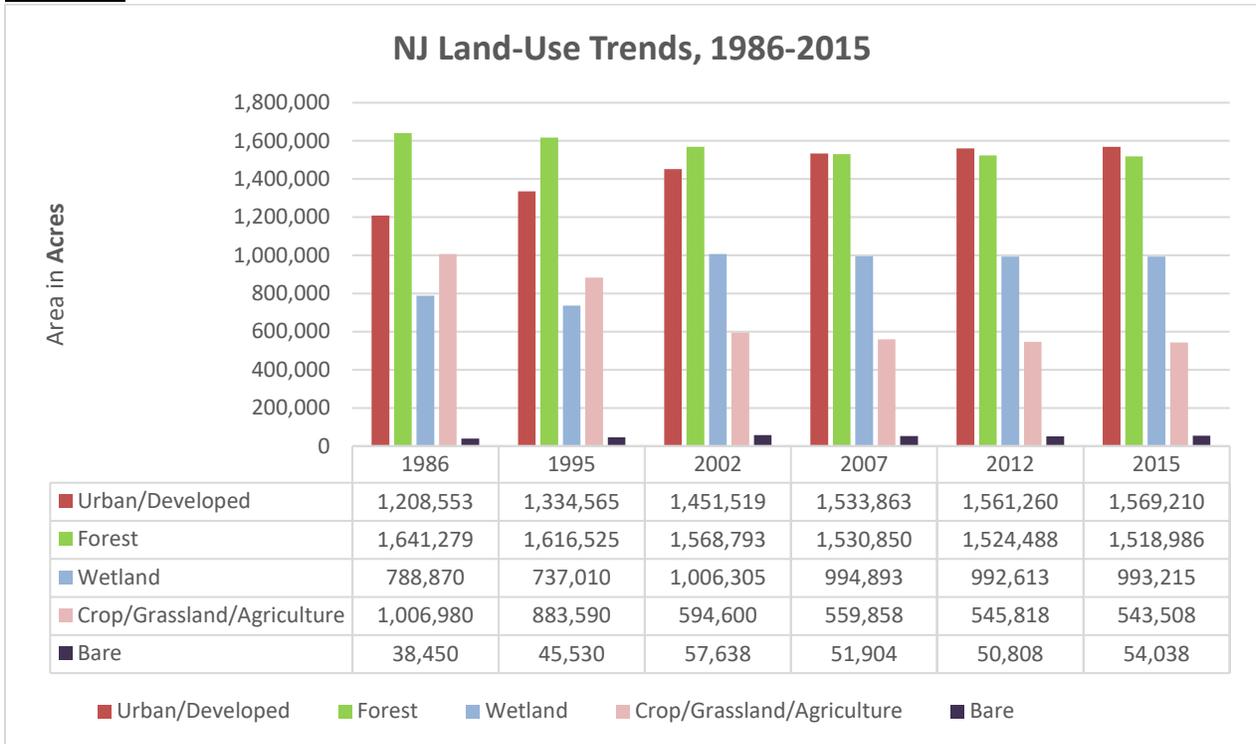
During a 26-year period from 1986 to 2012, NJDEP data shows an increase of almost 350,000 acres of development, nearly 37 acres per day on average. The losses of agricultural and forested lands is in large part due to increases in urban land. Recently though, the pace of wetland and forest loss has decreased. It should be noted that the historic high pace of development slowed down between 2007 and 2012 due to the economic recession, but has increased again in recent years due to the subsequent recovery. This is reflected in the trend of carbon emissions due to land clearing (Table 5). Figure 12 shows how land use changed over the years.

Table 5

Trend of Land Clearing Emissions in New Jersey 2006-2016 (million metric tons CO₂e)

2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
1.8	0.3	0.3	0.3	0.3	0.3	0.3	1.0	1.0	1.0	1.0

Figure 12



Source: NJDEP/Bureau of Geographic Information Systems

CONCLUDING NOTES

Overall, the State remained essentially at the same level of net emissions in the last 2-3 years. There were incremental increases and reductions in several sectors and sub-sectors. Relative to 2006, the noticeable increases in GHG emissions were in the residential, highly warming gases, and waste management. Although a new methodology was applied to estimate emissions in the two largest sub-sectors in transportation (with lower estimates), the sector itself remains as the largest GHG emissions source for the State. Likewise, emissions of highly warming halogenated gases were estimated using a new method. For consistency, the 2006 estimates were adjusted accordingly.

Appendix A: Changes in Greenhouse Gas Emissions Inventory Data and Methods in 2018

Transportation On-Road Gasoline and Distillate

Previously, estimates of transportation GHG emissions from these sub-sectors were based on fuel consumption data (fuel purchases/sales in the State) from the USDOE Energy Information Administration (EIA). This method yielded reasonable but conservative estimates. In this update, the U.S. Environmental Protection Agency's *Motor Vehicle Emission Simulator* (MOVES) model¹⁷ was used to estimate GHG emissions for these sub-sectors. MOVES is considered as a robust model providing accurate emission estimates as it accounts for, among others, fuel efficiency, vehicle types and vehicle miles traveled. Since it closely estimates fuel actually consumed within the State instead of fuel purchased within the State, the results obtained are lower than what the previous method yields. Since 2006 is the base year for the 2050 GHG emission reduction goal, the estimate for that year was also adjusted using MOVES. Based on the adjustment, the 2050 GHG reduction goal is now 24.1 million metric tons CO₂e. Prior reports listed the goal as 25.7 million metric tons CO₂e.

Residential, Commercial and Industrial

Since EIA state energy consumption data for 2017 and 2018 were not yet available at the time when this report was prepared, projections for the Mid-Atlantic region for these years included in the EIA's *Annual Energy Outlook* (AEO) 2018 were used. New Jersey's share of the projected regional consumption was estimated using 2016 energy consumption data for each of the states comprising the Mid-Atlantic region (New York, Pennsylvania, and New Jersey).

Halogenated Gases

The U.S. Climate Alliance (USCA) *GHG Inventory Tool for HFCs, Methane and Black Carbon* was used to estimate emissions of these high GWP gases which in recent years are comprised mainly of HFC compounds. This tool is considered an improvement over the USEPA methodology used in previous New Jersey GHG inventories. Estimation using the tool yielded results higher (by 5-8%) than those obtained via the USEPA method in the most recent years (2016-2018).

Out-of-State Landfills

Updated data on solid waste tonnage sent out of state provided by the DEP's Division of Solid and Hazardous Waste were used to calculate GHG emissions associated with exported waste.

¹⁷ NJDEP Bureau of Evaluation and Planning/Division of Air Quality generated the model results for years 2006, 2016, 2017 and 2018. Actual VMT was used for years 2006, 2016 and 2017. However, VMT projections were used for 2018 because actual VMT were not available at the time of this report.

Appendix B: Detailed GHG Emissions Estimates

Estimated NJ Statewide Greenhouse Gas Emissions						Notes
million metric tons CO ₂ eq						
Sector	1990	2006	2016	2017	2018	
<u>Energy</u>						
Commercial	10.7	9.2	10.9	9.0	9.4	
Industrial	19.8	16.3	7.5	6.8	7.2	
Residential	15.2	13.7	14.6	14.5	15.2	
Transportation						
on-road gasoline	28.9	34.0	31.2	30.8	29.4	MOVES* adjusted
distillate	5.6	7.8	8.2	8.0	7.9	MOVES adjusted
jet fuel	1.0	1.0	1.0	1.0	1.0	
residual	1.0	0.8	2.0	2.2	2.0	
other	0.4	0.3	0.4	0.4	0.3	
Electricity						
in-state electric	12.4	18.5	20.6	17.2	17.4	
imported electric	14.1	11.7				
MSW incineration	na	0.8	0.8	0.8	0.7	
<u>Non-energy</u>						
Halogenated gases (excl. SF ₆)	0.0	2.3	4.6	4.8	5.0	USCA-Tool** adjusted
SF ₆	1.0	0.3	0.1	0.1	0.1	
Agriculture	0.6	0.5	0.3	0.4	0.4	
Natural gas T&D	2.5	2.6	2.6	2.5	2.5	
Landfills						
in-state	11.7	3.5	3.2	3.1	3.1	
out-of-state	2.6	1.0	1.5	1.6	1.6	
industrial	1.1	0.2	0.2	0.2	0.2	
POTWs***	0.2	0.2	0.4	0.4	0.4	
Released thru land clearing	0.6	1.8	1.0	1.0	1.0	
Others-Industrial non-fuel related	0.3	0.1	0.3	0.3	0.3	
Total gross emissions, MMT	129.6	126.6	111.4	105.1	105.1	
Sequestered by forests and other land uses	-4.0	-6.0	-8.1	-8.1	-8.1	
Total net emissions MMT CO₂eq	125.6	120.6	103.3	97.0	97.0	

*Incorporates results of USEPA Motor Vehicles Emissions Simulator (MOVES) model which takes into account vehicle miles traveled (VMT).

**Adjusted using U.S. Climate Alliance (USCA) halogenated/fluorinated gas emission estimation methodology.

***POTW--publicly owned treatment works