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Maryland's GHG Inventory

Methane

Maryland Commission on Climate Change

Mitigation Working Group

February 24, 2017

Why an Emissions Inventory

- Required by the Clean Air Act/ GGRA
  - 3 Year Increments for Full Inventories
  - Points collected annually
- Track emissions relative to the SIP (State Clean Air Plan) Reasonable Further Progress Requirements/ GGRA
- Trends - Going up? Going down?
- Advises regulations
- Most importantly … identifies large and small source categories to provide focus for reduction opportunities

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Source Categories

Criteria Pollutants

- **Point (Major) Sources**
  - EGUs, Cement Plants, Incinerators
- **Stationary Area Sources**
  - Paint, Consumer Products, Residential Fuel Combustion
- **On-road Mobile Sources**
- **Non-road Mobile Sources**
  - Lawn & Garden, Construction Equipment
- **Marine-Air-Rail Sources**
- **Biogenic Sources**

Source Categories

GHG Emissions

- **Electricity Use (Consumption)**
- **Residential, Commercial, Industrial Fuel Use**
- **On-road Mobile Sources**
- **Non-road Mobile Sources**
  - Lawn & Garden, Construction Equipment, Marine, Air, Rail
- **Fossil Fuel Production, Industrial Processes, Agriculture, Waste Management, Etc.**
- **Sinks**

How are Criteria Emissions Estimated?

- Based upon the very best data available
- Perfect … No
- Very Good … Yes
- Estimation/Calculation process varies from one source to another
  - Point Sources – from MDE Registration Files
    - Continuous Monitors (CEMs), Stack Tests, Mass Balance, EF
  - Area – Activity level × an emissions factor
    - Surrogates used to estimate emissions
  - Non-road – M-A-R
    - Marine Vessels: Data from Baltimore Maritime Exchange & EPA
    - Railroads: Data directly from railways
    - Airports: Survey of Airport Data (LTOs)
  - Non-road Model – EPA's latest version
  - On-road – Mobile model called "MOVES"
  - Biogenic – EPA model (BEIS)

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How are GHG Emissions Estimated?

- Based upon the very best data available
- Perfect … No
- Very Good … Yes
- Estimation/Calculation process varies from one source to another
  - Electricity Consumption (direct read data, CEMS)
  - RCI – State specific fuel consumption data/Fuel specific carbon contents
  - Off Road and On Road (EPA model)
  - Waste Management (MDE collected data and EPA model)
  - Industrial (Pulp & Paper) – (direct read data, CEMS)
  - Industrial (Cement) – Facility/kiln-specific fuel consumption data; Clinker kiln dust data; Raw meal organic carbon content data
  - Most other categories (EPA Model)

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Overview

- The Greenhouse Gas Reduction Act (GGRA) requires MDE to report on the statewide greenhouse gas inventory every three years
  - Most recent update released based on 2014 data
  - Next update will be based on 2017 data
- 2014 Inventory covers six types of GHGs, including methane
- Emissions were estimated bottom-up using generally accepted principles and guidelines
  - Maryland specific data to the extent possible

Greenhouse Gas	GWP
Carbon Dioxide (CO_2)	1
Methane (CH_4)	21
Nitrous Oxide (N_2O)	310

- Equivalent CO_2 (CO_2e) was calculated using global warming potentials (GWP) from the IPCC 2nd Assessment Report

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Data Sources

- Mobile source emissions (both on-road and non-road) are generated using a well-accepted EPA model with inputs from data sets maintained by SHA, MDE, MVA and EIA

- Emissions from the majority of point sources are directly measured

- Non-point source calculations utilize state-specific consumption data, fuel-specific carbon content coefficients and EPA established emissions factors and methodology

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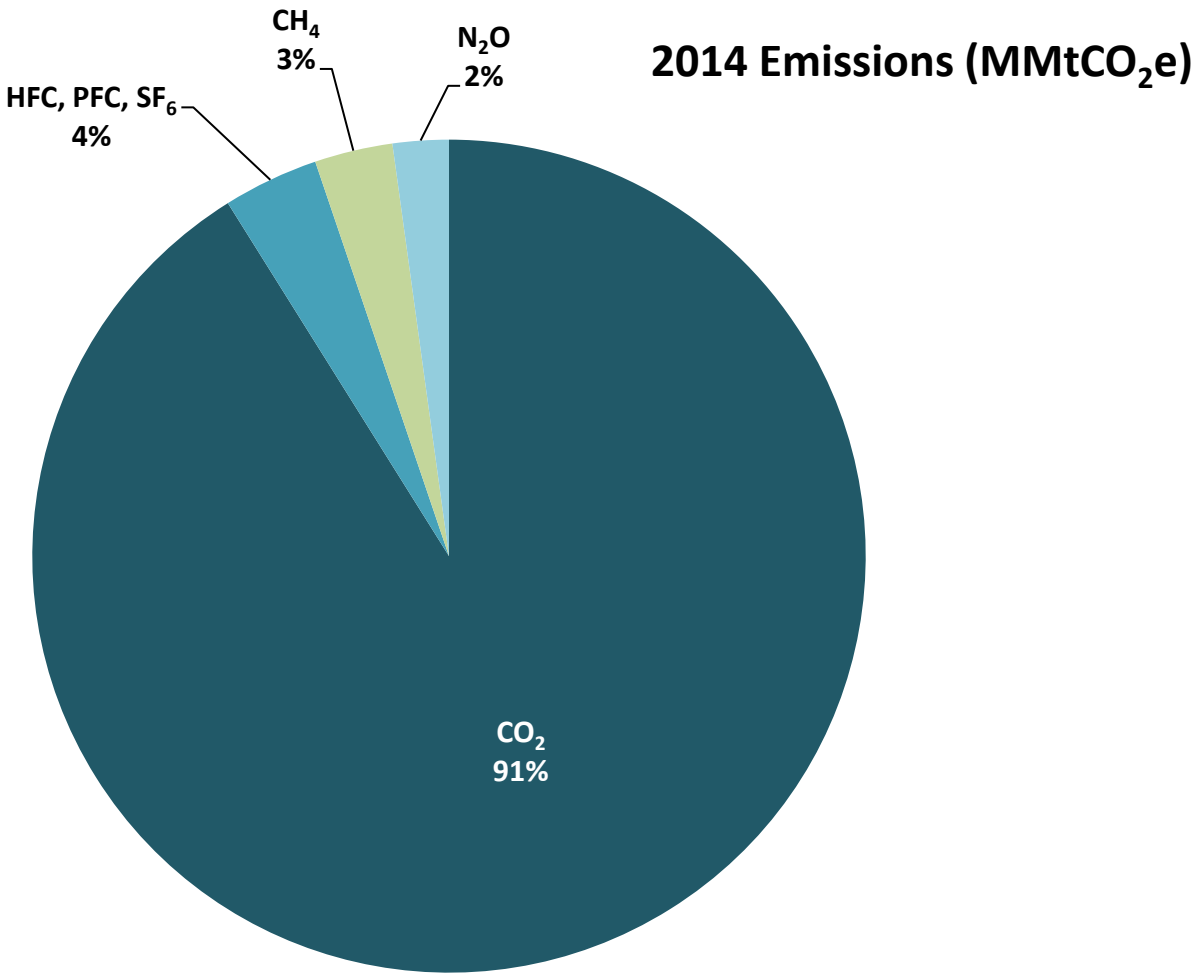
Results



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High level of confidence on over 90% of the inventory

CO_2 emissions from MD EGUs were compiled from CEMS/Emissions Certification Reports and cross-checked against two other reporting programs	**21.5%**
PJM provides both the fuel mix information and CO_2 emission rates for each fuel type to determine emissions from imported electricity	**17.1%**
EPA's well-accepted MOVES model was used to estimate on-road mobile emissions as well as most off-road mobile emissions	**34.6%**
R/C/I Fuel Use emissions estimates were calculated using MD specific fuel consumption data and carbon content coefficients specific to each fuel	**17.1%**

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Methane (CH_4)

The Basics

- Second most prevalent greenhouse gas emitted in the U.S. by human activities
  - EPA estimated 11% of national emissions in 2014
  - MDE estimated 3% of state emissions in 2014

- Shorter atmospheric lifetime than carbon dioxide (CO_2)
  - Approximately 12 years

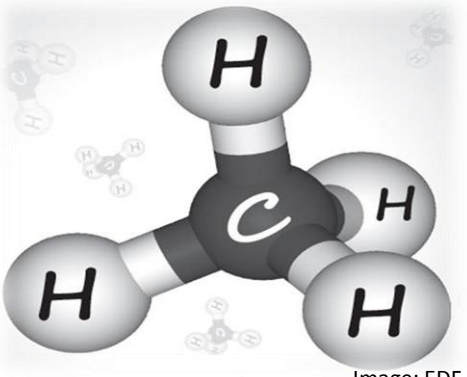

Image: EDF

- Higher global warming potential than CO_2
  - Approximately 28 times more effective than CO_2 at trapping heat in the atmosphere over 100 years
  - Approximately 84 times more effective over 20 years

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Methane Sources

- Leakage and venting of CH_4 from oil and gas fields, processing facilities, and natural gas pipelines
- Fugitive CH_4 emissions released during coal mining


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- Non-energy CH_4 from enteric fermentation, manure management, and agricultural soils
- CH_4 emissions from solid waste management in municipal and industrial landfills (including flared, captured for energy, and from municipal solid waste incinerators)
- CH_4 emissions from wastewater management
- CH_4 released during wildfires and prescribed forest burns

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Determination of Methane Emissions

Electricity Supply

- Data: annual direct emissions from Emissions Certification Reports submitted to MDE

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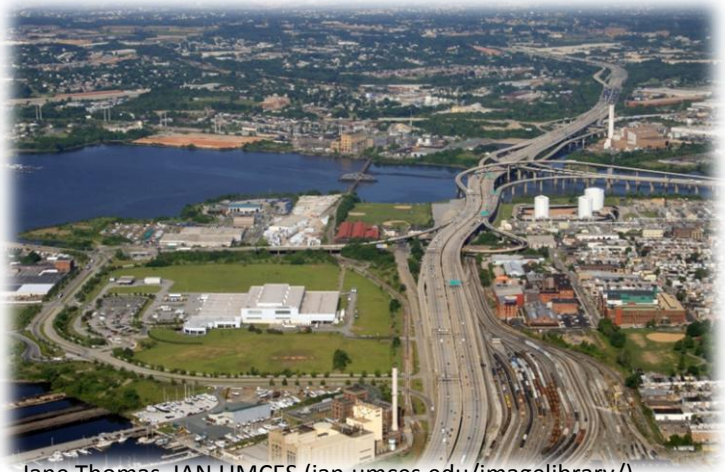
Residential, Commercial, and Industrial (RCI) Fuel Combustion

- Data: statewide energy consumption
- Calculations: default EPA's SIT emission factors, based on fuel type



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On-Road Mobile Energy Use

- Local Data:
  - SHA: VMT, vehicle mixes and seasonal/hourly factors
  - MVA: vehicle population and age
  - MDE: environmental and fuel data, control strategies
- Calculations: Mobile 6.2, PPSUITE and MOVES modeling

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Determination of Methane Emissions

Non-Road Mobile Energy Use

- Data:
  - Equipment population distributed by age, power, fuel type and application
  - Average load factor and available horsepower
  - Activity in hours of use per year
  - Emission factors
- Calculations: MOVES-NONROAD modeling
- Data: EIA Maryland fossil fuel consumption information (railroads, aviation, and commercial marine vessels)
- Calculations: EPA standard emission factor by fuel type

Husqvarna

Industrial Processes

- No raw material transformation and production processes analyzed emit CH_4

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Determination of Methane Emissions

Fossil Fuel Production Industry

- Data:
  - U.S. DOT (pipeline information)
  - EIA (natural gas production information)
  - U.S. DOI (surface mining information)
- Calculations: EPA's SIT default emission factors and methods provided in the Emission Inventory Improvement Program (EIIP)

UMCP dairy farm

Agriculture

- Data: USDA Maryland data on animal populations, fertilizer consumption, crop production and dry matter burned
- Calculations: EPA's SIT with reference to methods in the EIIP

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Determination of Methane Emissions


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Waste Management

- Solid Waste Data:
  - MSW Landfill-specific data and control device information from MDE programs
  - Annual waste emplacement data (including type of waste)
- Solid Waste Calculations:
  - Emissions based on landfill-specific technology efficiencies
  - EPA default surface oxidation factor
  - Industrial landfill emissions assumed to be 7% of municipal emissions
- Wastewater Data: state population
- Wastewater Calculations: default biochemical oxygen demand and emissions factors from EPA's SIT

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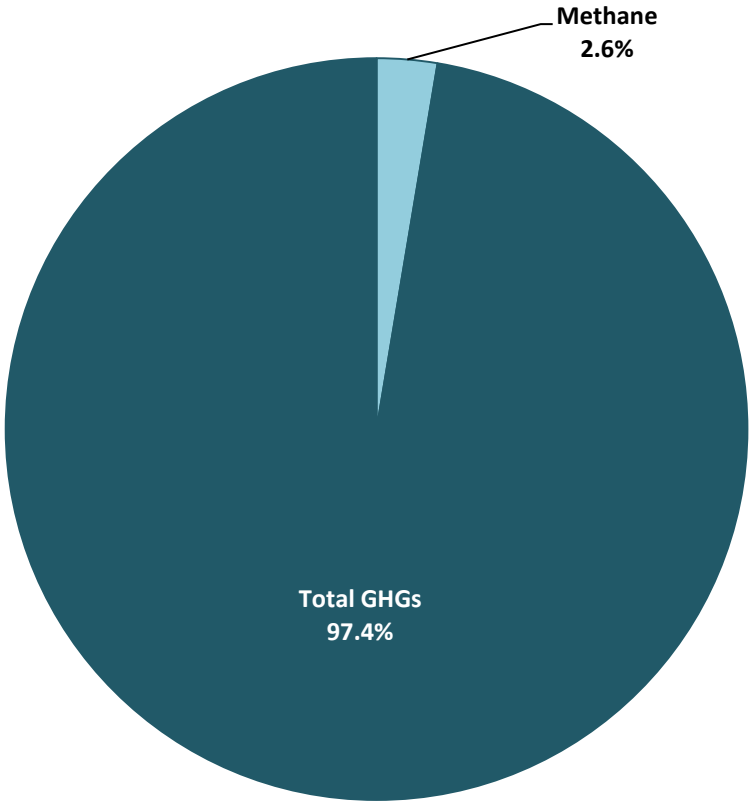
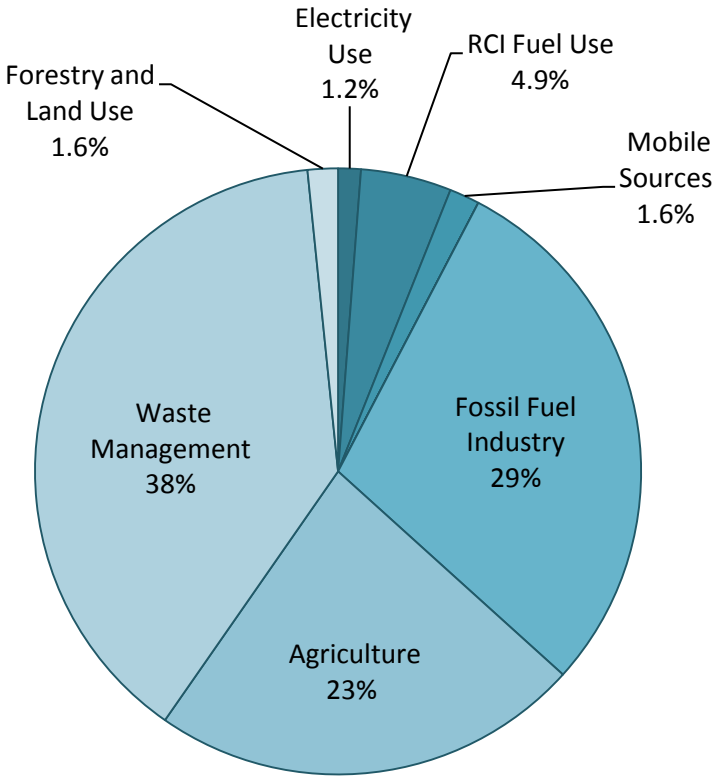
Methane Results

All GHGs (2014)



Methane Breakdown (2014)



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Methane Results

2014 Emissions (MMt CO_2e)		
Sector	Methane	Total GHGs
Electricity Use	0.03	33.76
RCI Fuel Use	0.12	15.80
Mobile Sources	0.04	33.45
Industrial Processes	0.00	04.78
Fossil Fuel Industry	0.72	00.72
Agriculture	0.57	01.89
Waste Management	0.96	02.26
Forestry and Land Use	0.04	-11.65
Total Emissions	**2.47**	**92.67**

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Methane Results

Sector		CH_4 Emissions ($MMtCO_2e$)
RCI Fuel Use		0.1173
	Wood	0.0875
	Natural Gas & LPG	0.0198
	Petroleum	0.0068
	Coal	0.0032
Mobile Sources		0.0315
	Lawn & Garden Equipment	0.0121
	Recreational Equipment & Craft	0.0083
	Construction Equipment & Fuel	0.0065
	Commercial Equip.	0.0044
	Industrial Equipment & Fuel	0.0030
	Highway Vehicles	0.0011
	Other	0.0024

Sector		CH_4 Emissions ($MMtCO_2e$)
Electricity Production (in-state)		0.0323
	Coal	0.0296
	Natural Gas	0.0024
	Oil	0.0003
Fossil Fuel Industry		0.719
	Natural Gas Industry	0.584
	Coal Mining	0.135
Agriculture		0.572
	Enteric Fermentation	0.338
	Agricultural Burning	0.143
	Manure Management	0.090
Waste Management		
	Landfills	0.556
	Wastewater Management	0.403
Forest Fires		0.040

Reducing Maryland's Methane

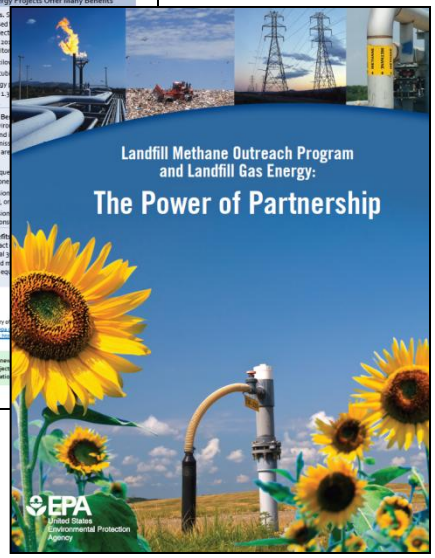
- MDE conducted research on both current and anticipated future emissions, to prioritize three source categories for initial action:
  - Landfills
  - Compressor Stations
  - Wastewater Treatment Plants


Green Power from Landfill Gas

Improving the environment while sustainably fueling the economy

What is Landfill Gas?

EPA's Interest in LFG Energy



- EPA has a number of voluntary programs and regulatory initiatives to reduce methane emissions, including the Landfill Methane Outreach Program
  - Maryland already has 12 operational LFG energy projects

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Reducing Maryland's Methane

Updated regulations for hydraulic fracturing

- In 2015, Maryland established a 2 year moratorium on fracking which remains in effect until October 2017
- MDE held three public meetings in June last year to solicit comments on draft regulations for oil and gas exploration and production
- Final regulations were proposed in October 2016

Methane leakage-related fracking requirements:

- Top-Down Best Available Control Technology (BACT) required for all emitting equipment and leaks
  - Includes comprehensive LDAR programs
- Methane offset requirement
- State sponsored air monitoring
- Compliance with State air toxics requirements

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Neighboring States

Pennsylvania's Initiative

- Early last year, Pennsylvania's governor Tom Wolf announced a strategy to reduce methane emissions from the oil and natural gas industries, calling it "one of the essential steps needed to reduce global greenhouse gas emissions and reduce the impacts of climate change".

- The plan includes four main strategies:
    1. Revise the general permit for new pads to include BAT for equipment and processes, better record keeping, and quarterly inspections
    2. Revise the general permit to update BAT requirements and apply more stringent LDAR for new compressor stations and processing facilities
    3. Develop requirements for existing oil and NG facilities for the consideration of the Environmental Quality Board
    4. Establish BMP for pipelines that include leak detection and repair programs

- In November, the governor entered into a partnership with EDF, Google, and Carnegie Mellon University to map methane leaks in Pittsburgh

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Questions ?